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A behavior setting approach to social accounts

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A behavior setting approach to

social accounts

by

Walter Gbute Ollor

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I. INTRODUCTION

Chapter I presents a review of previous work and sets forth the questions engaged in the dissertation.

A. Review of Previous Work

This study draws on two very different research traditions. The first is Roger Barker's discipline of ecological psychology and particularly the concepts of behavior settings and behavior mechanisms which he has used since 1947 in comprehensive surveys of human behavior and time allocation in two towns, one in Kansas and one in England. The second is social accounting in a sense which includes, but is much broader than, the existing national income and product accounts. The first major conceptualization of this field was Bertram Gross's (1966) paper, "The State of the Nation: Social Systems Accounting", in Bauer, ed., Social Indicators, a book which had great influence on the development of the social indicators movement.

By the mid-1970's, several economists, sociologists, and social psychologists were beginning to talk about "social accounting" as a distinct specialty within the social indicators movement. The first workshop devoted to a critique and appraisal of research by these social scientists was held in Washington, D.C. during March 24-26, 1980 under the sponsorship of the Social Science Research Council. At this workshop on Social Accounting Systems, commissioned papers were presented by Richard Stone, Karl Fox, Thomas Juster, Nestor Terleckyj, Richard

Ruggles, Kenneth Land, Marcus Felson, James House, and Frank Andrews. The first five named were economists, the next two sociologists, and the last two social psychologists.

The papers by Fox and Juster both dealt with time-based social accounts. Their common feature is an exhaustive classification of all living-time (8,760 hours per person per year) of a population into categories of activities (work, housework, shopping, recreation, and the like). These time-use accounts are stated in person-hours, and contain no necessary implications for imputing dollar values to the various time uses.

Juster and Fox propose to impute dollar values to the various uses of time. Both would use money earnings in gainful employment as a starting point for imputing values per person-hour to the various nonmarket uses of time. Juster would emphasize a subjective approach, in which individuals would be asked to rate their degrees of liking or disliking of each activity (including work) on a common scale, say 0 to 10. If a person rated his liking for some nonwork activity at a higher figure than his liking for his work, that nonwork activity would be given an imputed hourly value higher than that of an hour on the job.

Fox would use an objective approach, based on the observed intensity of use of four categories of behavior mechanisms in each activity. The value per unit of each behavior mechanism (kind of input) used in gainful employment would be estimated from data on occupations and earnings. A vector of behavior inputs valued at $5 (say) an hour in gainful employment would be given the same imputed value of $5 in any nonmarket activity.

It should be stressed that social systems accounting is in a very early stage of development. The March 1980 workshop papers [to be published in 1981] might be compared with those in Volume One of the National Bureau of Economic Research series, Studies in Income and Wealth, published in 1937. Bertram Gross (1966) seems to have correctly anticipated developments in social accounting when he predicted that "the maturation of social accounting concepts will take many decades". Gross also pointed out that "it took centuries for Quesnay's economic tables to mature into national income accounting" and that even in countries where national income accounting is highly developed, "national income experts recognize that they face many conceptual problems that still require years of dedicated attention".

Because of its dependence on concepts from ecological psychology and from the new interdisciplinary field of social accounting systems, this dissertation will use some terms which are not yet familiar to most economists. We shall define and illustrate these terms to the best of our ability. On this point, Gross asserted that "the formulation of national social accounts is a much more complex undertaking [than the national economic accounts]. It requires the participation of social scientists from many disciplines and the breaking down of many language barriers among them" (p. 271).

1. Roger Barker and Associates on behavior settings

Roger Barker asserts that the environment of human behavior is exhaustively partitioned into spatio-temporal entities called behavior settings. In many cases, a behavior setting coincides with an establishment; for example, Jones Barber Shop is a behavior setting to Barker and an establishment (and also a firm) to economists. Barber shops in general constitute a genotype in Barker's terminology and an industry to economists.

An establishment may consist of two or more behavior settings. Thus, the Eggleston and Dean Window and Door Company in Midwest, Kansas consists of one behavior setting of Genotype 64, Factory Assembly Shops, and one of Genotype 38, Commercial Company Offices. The patterns of behavior in the two settings are distinctly different, and the sizes, shapes, and equipment of the two work areas are designed to facilitate the respective patterns. Engineers and architects can see at once why the physical arrangements must be adapted to the desired behaviors and job analysts will recognize that the tasks to be performed require different occupational skills.

The behavior settings cited belong to what Barker calls the private enterprise "authority system". The economist's terminology of establishments and industries is seldom extended beyond the private enterprise sector. However, Barker applies his concepts of behavior settings and genotypes to all "authority systems", namely private enterprise, government, school, church, voluntary association, and household. Collectively, behavior settings in these six authority systems contain all human behavior, and all human time is allocated among such settings.

The quickest way to dispel any sense of mystery as to what behavior settings are is to present a summary table from Barker's survey of all the nonhousehold behavior settings that occurred in Midwest, Kansas from September 1, 1963 through August 31, 1964. Midwest (Barker's code name for Oskaloosa, Kansas) is a county seat town; as of 1963-64 the town had 830 residents and served a retail trade area, school district, and church attendance area of about 50 square miles. The population of the town and trade area combined was about 1500 persons.

Table 1 is an exact reproduction of Table 5.3 in Barker (1968, pp. 110-116). The town's 884 behavior settings are classified into 198 genotypes.[1] The entries for Genotype 1, Abstract and Title Company Offices, have the following meanings: N = 1 (there is only one behavior setting in this genotype); O = 305 (the behavior setting occurred, i.e., was open for business, on 305 different days); D = 2,500 (the setting was open about 8.2 hours a day, so its duration was 2,500 hours for the year as a whole); Town OT = 4,054 (town residents spent 4,054 person-hours of occupancy time in the setting); and Total OT = 4,606 (occupancy time by town residents and nonresidents combined totaled 4,606 person-hours). We have not used the ERI column in our research and will not comment on it.

At a certain level of aggregation, Table 1 provides the framework for a complete set of social accounts for the nonhousehold behavior settings of Midwest during the survey year. In fact, Barker (1968, p. 116) summarizes the message of Table 1 as follows:

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[1] The genotypes in Table 1 are numbered from 1 to 220, with 22 omissions; the omissions are genotypes Barker found in Midwest in 1954-55 but not in 1963-64.

> These data show that there are 198 genotypes among Midwest's 884 behavior settings, i.e., 198 standing patterns of behavior and milieu with noninterchangeable programs. If the town were abandoned by its present inhabitants and resettled by people of totally alien culture, they would require 198 instruction books and/or training programs to reconstitute the behavior environment of Midwest. A person familiar with midwestern American culture is informed by the genotype list and the data on their extents of the behavior possibilities within Midwest in the same way that a soil survey tells an agronomist of the suitability of Midwest County for the production of corn, walnut trees, hay, etc. (p. 116).

We believe Barker's approach has great potential for describing changes in a community (or a nation) over time and describing differences between communities (or nations) at a given time. In fact, Barker and Schoggen (1973) make both kinds of comparisons: Midwest, Kansas in 1963-64 versus 1954-55; Yoredale, Yorkshire in 1963-64 versus 1954-55; Midwest versus Yoredale in 1954-55; and Midwest versus Yoredale in 1963-64. If their catalogs of genotypes were extended to include those found in households, each behavior setting survey (for example, of Midwest in 1963-64) would provide the exhaustive accounting for living-time required by the Juster and Fox approaches to time-based social accounts along with much additional information.

Figure 1 is a reproduction of Figure 5.1 in Barker (1968, p. 99), "Data sheet of behavior setting 18.5: High School Boys Basketball Game". The program of Genotype 18, Basketball Games, reads as follows (the numbers in parentheses refer to the penetration zones of the setting, as defined in Table 2, page 18):

> Coach (6) or coaches (5) arrange games, instruct players; referees (4) judge plays: players (4) play according to standard basketball rules; cheerleaders (4) lead cheers; salesmen (4) sell popcorn, soft drinks; band (4) plays music in intervals; audience (2) watch, cheer, applaud, eat (Barker, 1968, p. 212).

TABLE 1. *Behavior Setting Genotypes of Midwest, 1963–64. Number* (N), *Occurrence* (O), *Duration* (D), *Ecological Resource Index* (ERI), *Occupancy Time of Town Residents* (Town OT), *and Occupancy Time of All Inhabitants* (Total OT) *of Behavior Settings in Each Genotype*°

		Resource Measures				Output Measures	
No.	Genotype	N	O	D	ERI	Town OT	Total OT
1.	Abstract and Title Company Offices	1	305	2,500	0.52	4,054	4,606
2.	Agricultural Advisors Offices	1	250	2,040	0.43	5,206	6,559
4.	Agronomy Classes	2	4	13	0.08	72	341
5.	Animal Feed Mills	1	310	3,344	0.62	8,998	16,881
6.	Animal Feed Stores	1	307	2,736	0.55	5,857	8,127
7.	Animal Husbandry Classes	4	6	20	0.16	23	394
8.	Athletic Equipment Rooms	2	265	180	0.26	284	412
9.	Attorneys Offices	4	1,155	7,250	1.72	20,594	23,347
10.	Auction Sales	2	3	14	0.08	485	1,645
11.	Auditing and Investigating Co. Offices	1	250	2,000	0.47	2,320	2,380
12.	Automobile Washing Services	2	3	18	0.08	113	143
13.	Award Ceremonies	3	3	5	0.12	176	283
14.	Bakery Services, to Order	1	50	200	0.09	242	242
15.	Banks	1	305	1,750	0.43	26,499	36,860
16.	Barbershops	2	450	3,600	0.78	2,760	7,601
17.	Baseball Games	16	71	167	0.67	6,781	13,691
18.	Basketball Games	14	124	272	0.64	14,164	36,058
19.	Beauty Shops	1	305	3,329	0.62	13,099	15,549
20.	Billiard Parlors and Taverns	1	308	4,300	0.73	21,330	39,212
22.	Bowling Games, Ten Pins	25	725	3,204	1.77	23,862	41,214
24.	Building, Construction, Repair Services	6	1,135	9,160	2.00	14,155	19,564

° The complete, alphabetized, and numbered genotype list covers two survey years, 1954–55 and 1963–64. Genotypes that were present in the former year and absent in the latter year are omitted from the 1963–64 list; hence the genotype numbers are not consecutive. The occupancy times reported are from the coded values (see Appendix 1).

Table 1 *(continued)*

No.	Genotype	N	Resource Measures O	D	ERI	Output Measures Town OT	Total OT
25.	Bus Stops	2	546	42	0.42	50	1,984
26.	Card Parties	8	64	238	0.37	1,985	2,543
27.	Carnivals	1	1	3	0.04	443	575
28.	Cemeteries	1	366	1,594	0.45	1,364	1,636
29.	Charivaris	1	5	3	0.04	114	242
30.	Chiropractors Offices	1	170	864	0.24	114	914
32.	Civil Engineers Offices	1	250	2,040	0.43	3,548	6,559
33.	Classrooms, Free Time	15	2,700	1,462	2.42	8,382	18,557
34.	Cleaners, Dry Cleaning Plants	1	365	2,500	0.52	6,559	6,770
35.	Clothiers and Dry Goods Stores	1	307	3,059	0.59	14,289	21,330
36.	Club Officers Training Classes	1	1	2	0.04	21	114
37.	Commercial Classes	1	180	990	0.27	7,315	13,099
38.	Commercial Company Offices	1	250	2,040	0.43	7,000	7,200
39.	Cooking Classes	3	6	14	0.12	39	104
40.	Court Sessions, County	1	240	500	0.25	731	914
41.	Court Sessions, District	1	30	140	0.07	333	1,364
44.	Custodial Work Groups	4	64	196	0.21	346	1,459
46.	Dances	4	10	12	0.16	658	1,330
47.	Day Care Homes and Nurseries	5	409	2,527	0.74	6,771	21,825
48.	Delivery and Collection Routes	6	1,297	2,572	1.34	5,955	7,436
49.	Dentists Offices and Services	2	221	1,509	0.39	1,385	4,678
50.	Dinners and Banquets	13	29	57	0.52	927	1,939
51.	Dinners with Business Meetings	17	38	98	0.68	1,829	4,146
52.	Dinners with Dances	1	1	4	0.04	333	575
53.	Dinners with Recreational Programs	16	18	46	0.62	2,381	5,786
54.	Drugstores	1	307	3,339	0.62	30,371	39,212
55.	Educational Methods Classes	3	5	12	0.12	188	943
56.	Elections, Polling Places	4	4	40	0.16	268	427
57.	Elections, Public Posting of Returns	1	1	4	0.04	72	114
58.	Elementary School Basic Classes	13	2,250	8,945	2.94	98,251	222,119

Table 1 (*continued*)

No.	Genotype	N	O (Resource Measures)	D (Resource Measures)	ERI (Resource Measures)	Town OT (Output Measures)	Total OT (Output Measures)
59.	English Classes	2	181	669	0.27	9,019	16,923
60.	Examinations, Boy Scout	1	3	1	0.04	9	9
61.	Examinations, Standardized	5	6	16	0.19	184	361
62.	Excavating Contracting Services	3	340	1,380	0.49	1,905	2,298
63.	Excursions and Sight-seeing Trips	15	18	124	0.59	2,033	3,957
64.	Factory Assembly Shops	1	270	2,643	0.51	6,559	18,288
65.	Farm Implement Agencies	2	620	3,500	0.87	5,730	13,051
67.	Fashion Shows	2	2	7	0.08	62	113
68.	Fire Alarms and Fire Fighting	2	22	9	0.09	284	314
69.	Fire Drills	2	18	2	0.09	185	412
70.	Fire Stations	2	309	1,009	0.39	1,195	1,195
71.	Fireworks Sales Stands	2	18	150	0.10	155	228
72.	Floor-laying Services	1	60	400	0.12	575	914
73.	Food and Rummage Sales	7	9	42	0.27	106	198
74.	Football Games (American Football)	5	52	114	0.23	6,911	15,144
75.	Funeral Directors Services	1	180	46	0.16	443	731
76.	Funeral Services, Church	3	16	17	0.13	817	1,602
77.	Furniture Stores	1	305	2,700	0.55	10,920	11,976
78.	Garages	2	620	6,600	1.23	19,856	28,578
79.	Gift Showers	3	13	28	0.12	421	511
80.	Golf Games	3	243	888	0.37	2,496	3,005
81.	Government Offices: Business, Records	9	1,997	15,124	3.35	27,386	75,140
82.	Graduation and Promotion Ceremonies	4	4	6	0.15	495	1,131
83.	Grocery Stores	3	654	7,118	1.35	66,396	83,187
84.	Hallways	4	950	8,100	1.69	26,275	71,356
85.	Hardware Stores	2	610	5,060	1.05	10,106	12,181
86.	Hayrack Rides	1	1	3	0.04	72	81
87.	Hikes and Camps	4	21	309	0.20	2,988	3,991
88.	Home Economics Classes	5	189	521	0.37	2,526	4,115
89.	Home Economics Competitions	2	2	4	0.08	44	446
90.	Horseshoe Pitching Contests	1	1	1	0.04	9	21

Table 1 *(continued)*

No.	Genotype	N	O	D	ERI	Town OT	Total OT
		Resource Measures				Output Measures	
92.	Hotels	3	766	2,975	0.94	3,312	4,293
93.	Ice Cream Socials	2	2	4	0.08	113	143
96.	Installation and Induction Ceremonies	3	3	6	0.12	114	283
97.	Insurance Offices and Sales Routes	2	500	3,400	0.78	4,671	5,418
98.	Ironing Services	5	350	2,400	0.69	2,460	2,460
99.	Jails	1	366	8,784	1.29	9,037	9,237
100.	Jewelry Stores	1	300	2,200	0.48	4,054	4,606
101.	Judges Chambers	2	300	2,380	0.54	3,199	3,816
102.	Kennels	2	720	1,090	0.65	1,170	1,186
103.	Kindergarten Classes	1	97	242	0.13	2,285	3,548
104.	Knitting Classes and Services	2	45	186	0.13	412	503
105.	Land Condemnation Hearings	1	2	12	0.04	21	114
106.	Landscaping and Floriculture Classes	1	1	4	0.04	72	242
107.	Latin Classes	2	181	341	0.23	3,199	5,449
108.	Laundries, Self-Service	1	366	8,784	1.29	10,920	22,970
109.	Laundry Services	1	300	2,400	0.50	5,206	5,467
110.	Libraries	3	338	1,653	0.52	15,425	29,625
111.	Locker and Shower Rooms	2	360	70	0.31	2,368	4,722
112.	Lodge Meetings	7	137	325	0.39	2,464	6,425
114.	Lumberyards	2	600	4,700	1.00	8,141	10,412
115.	Machinery Repair Shops	4	701	2,622	0.89	6,662	11,224
116.	Mathematics Classes	1	180	660	0.23	5,857	9,929
117.	Meetings, Business	103	684	1,544	4.49	5,054	15,562
118.	Meetings, Cultural	20	136	266	0.87	4,822	7,144
119.	Meetings, Discussion	12	23	56	0.47	629	1,550
120.	Meetings, Social	3	16	31	0.13	383	578
121.	Memorial Services	1	1	1	0.04	21	30
122.	Motor Vehicle Operators Classes, Exams	2	102	178	0.16	1,708	3,240
123.	Moving Picture Shows	2	13	35	0.09	817	1,356
124.	Music Classes, Instrumental	7	600	987	0.88	5,168	8,325
125.	Music Classes, Vocal	10	875	970	1.04	13,512	29,798
126.	Music Competitions	2	3	11	0.08	179	356
127.	Newspaper Reporters Beats	1	50	100	0.08	114	170

Table 1 (*continued*)

No.	Genotype	Resource Measures N	O	D	ERI	Output Measures Town OT	Total OT
128.	Newspaper and Printing Plants	1	300	2,500	0.52	9,928	10,920
129.	Nursing Homes	1	366	3,650	0.69	6,605	6,805
130.	Optometrists Services	1	1	5	0.04	72	242
131.	Painting Classes	1	33	100	0.07	443	914
132.	Parades	7	16	37	0.28	1,543	2,766
133.	Parking Lots	1	366	2,800	0.59	1,943	4,054
134.	Parks and Playgrounds	4	1,464	1,808	1.28	16,514	29,670
135.	Parties	16	195	78	0.73	1,225	2,637
136.	Parties, Stag	1	1	7	0.04	170	333
137.	Pastors Studies	1	260	1,100	0.33	1,148	1,198
138.	Photographic Studios	5	5	36	0.20	169	387
139.	Physical and Biol. Science Classes	2	276	726	0.33	5,520	10,634
140.	Physical Education Classes	11	1,836	1,209	1.70	17,143	37,685
142.	Piano Recitals	2	2	2	0.08	50	93
143.	Picnics	8	9	31	0.31	386	982
144.	Plays and Programs	28	86	196	1.13	6,291	15,458
145.	Plumbing, Heating, and Electrical Companies	2	600	3,000	0.80	6,170	7,691
146.	Post Offices	1	366	3,024	0.62	13,099	19,770
147.	Programs of Band Music	5	29	71	0.22	1,044	1,810
148.	Programs of Choral Music	6	7	16	0.23	758	3,513
149.	Psychological Research Offices	1	250	2,040	0.43	8,998	10,920
150.	Psychological Service Offices	1	250	1,008	0.31	1,124	1,364
151.	Public Speaking and Drama Competitions	2	2	8	0.08	123	356
153.	Real Estate Agents Offices	3	325	1,200	0.46	1,699	1,809
154.	Receptions	2	5	20	0.08	191	404
155.	Refreshment Stands	1	3	26	0.04	114	242
156.	Refuse Hauling Services	2	210	1,020	0.33	1,018	1,018
157.	Religion Classes	42	1,707	1,573	2.33	7,657	14,329
158.	Religion Study Groups	25	372	431	1.23	2,602	5,382
159.	Religious Fellowship Meetings	10	95	146	0.45	731	1,565
160.	Religious Prayer, Meditation Services	6	125	146	0.32	696	2,293

Table 1 (*continued*)

No.	Genotype	N	Resource Measures O	Resource Measures D	ERI	Output Measures Town OT	Output Measures Total OT
161.	Religious Worship Services	24	535	440	1.29	12,648	26,435
162.	Restaurants and Dinners for the Public	15	1,352	12,821	2.90	91,037	118,860
163.	Retarded Childrens Classes	1	42	84	0.07	443	914
164.	Roller Skating Parties	3	13	44	0.13	292	979
166.	Sales Promotion Openings	9	10	87	0.36	800	1,775
167.	Sales Promotion Parties	1	4	7	0.04	72	90
168.	Sales Routes	7	259	1,142	0.56	1,439	1,633
169.	Savings Stamp Sales Stands	1	20	5	0.05	72	114
170.	School Administrators Offices	3	650	4,060	0.99	3,549	7,975
172.	School Enrollment Periods	3	3	14	0.12	194	433
173.	School Offices	2	380	2,380	0.59	1,969	4,497
174.	School Rallies	5	47	50	0.22	598	1,066
175.	Scout Meetings	7	186	222	0.41	1,599	1,858
177.	Service Stations	4	1,408	15,780	2.87	28,408	39,281
178.	Sewing and Dressmaking Classes	3	14	30	0.13	155	227
179.	Sewing Club Meetings	2	49	286	0.14	2,399	2,479
180.	Sewing Services	2	400	2,400	0.60	2,518	2,674
181.	Sheriffs Offices	1	250	2,040	0.43	4,920	5,206
183.	Sign Painting Services	1	75	500	0.14	515	515
184.	Social Science Classes	2	270	578	0.31	6,330	12,213
185.	Soil Conservation Service Offices	1	250	2,040	0.43	1,636	2,665
186.	Solicitation of Funds	10	35	113	0.41	388	448
187.	Solicitation of Goods	1	10	70	0.05	41	170
188.	Speech Therapy Services	2	80	180	0.15	284	412
189.	Spelling Bees	1	1	2	0.04	0	242
190.	Staff Lounges	1	190	400	0.20	333	575
191.	Street Fairs	2	4	24	0.08	3,589	12,048
192.	Swimming Excursions and Classes	4	32	76	0.18	2,601	4,413
193.	Tank Truck Lines	1	300	1,000	0.34	1,124	1,124
194.	Taverns	1	308	4,450	0.75	13,099	18,288
195.	Teacher Conferences with Parents	2	2	16	0.08	113	185
196.	Telephone Automatic Exchange Buildings	1	300	600	0.30	575	914

Table 1 *(continued)*

No.	Genotype	N	Resource Measures O	Resource Measures D	EBI	Output Measures Town OT	Output Measures Total OT
197.	Telephone Booths	1	366	400	0.31	333	443
199.	Timber Sales and Tree Removal Services	1	125	500	0.17	1,124	1,364
200.	Tool Sharpening Services	1	250	650	0.27	700	710
201.	Track and Field Meets	7	44	130	0.31	3,511	7,739
202.	Tractor Pulling Contests	1	1	3	0.04	575	1,636
203.	Trafficways	1	366	8,784	1.29	87,376	95,827
204.	Trips by Organizations to Visit Sick	1	8	32	0.05	170	242
205.	TV and Radio Repair Shops	1	300	2,000	0.46	2,222	2,232
208.	Variety Stores	1	305	3,060	0.58	15,549	21,330
210.	Vocational Counseling Services	1	1	6	0.04	72	170
211.	Volleyball Games	2	5	14	0.08	575	1,489
212.	Wallpapering and Painting Services	2	52	400	0.15	446	446
213.	Water Supply Plants	1	366	250	0.30	333	333
214.	Weed Inspectors Offices	1	250	330	0.23	3	333
215.	Weddings, Church	2	5	8	0.08	284	974
216.	Weddings, Civil	1	27	7	0.06	9	21
217.	Welfare Offices	1	250	2,040	0.43	7,315	21,330
218.	Welfare Workers Classes	1	1	6	0.04	9	114
219.	Woodworking and Machine Shop Classes	1	180	495	0.21	2,285	4,606
220.	X Ray Laboratories	1	1	6	0.04	41	72

Name: High School Boys Basketball Game

Genotype # 1-3: 0·1·8	Genotype Commonality # 8: 9	Locus 16: 1
B S # 4-6: 0·0·5	Authority System 13-14: 0·1	No. of Occurr. 17-19: 0·0·8
Genotype Date 7: 3	Class of Authority Systems 15: 4	Survey # 20: 6

Occupancy Time of Town Subgroups Group	No. P	Hours	OT Code	Max. Penetration of Subgroups Group		ACTION PATTERN RATINGS
Inf	3	24	21-22: 0·4	Inf	21: 1	Aes: 53: 0
Presch	12	54	23-24: 0·5	Presch	22: 2	Bus 54: 1
Y S	10	87	25-26: 0·6	Y S	23: 2	Prof 55: 1
O S	18	258	27-28: 0·9	O S	24: 4	Educ 56: 1
Town Child	43	423	29-30: 1·1			Govt 57: 1
Adol	63	1720	31-32: 1·7	Adol	25: 4	Nutr 58: 1
Adult	72	1676	33-34: 1·7	Adult	26: 5	
Aged	7	81	35-36: 0·6	Aged	27: 2	PersAp 60: 2
Town Total	185	3900	37-38: 2·3	Grand Max	28: 5	
Males	97	2264	39-40: 1·9	Males	29: 5	PhysH 62: 2
Female	88	1636	41-42: 1·7	Females	30: 4	Rec 63: 8
I	35	600	43-44: 1·2	I	31: 4	Rel 64: 0
II	105	2236	45-46: 1·9	II	32: 5	Soc 65: 6
III	42	1014	47-48: 1·4	III	33: 4	MECHANISM RATINGS Affe 66: 9
N-G	3	50	49-50: 0·5	N-G	34: 4	GroMot 67: 7

POPULATION (number)		PERFORMERS (number)		
				Manip 68: 7
Town Child	51-53: 0·4·3	Town Child	35-36: 01	Talk 69: 9
Out Child	54-56: 1·8·7	Out Child	37-38: 00	Think 70: 4
Total Child	57-59: 2·3·0	Tot Child	39-40: 01	GEN RICH 71-72: 23
Town Total	60-62: 1·8·5	Town Total	41-42: 53	
Out Total	63-65: 9·3·7	Out Total	43-45: 2·4·9	PRESSURE RATING Children 73: 4
Grand Total	66-69: 1 1 2 2	Grand Tot	46-48: 3·0·2	Adolesc 74: 2
Grand O.T.(code)	70: blank 71-73: 0 3 1	Perf/Pop	49-50: 2·7	Children 75: 0
Total Duration	74-77: 0 0 2 4	Aver. No.	51-52: 8 4	WELFARE RATING Adolesc 76: 3
Average Attendance	78-80: 3 6 3			AUTONOMY RATING wtd 79: 7

Figure 1. Data sheet of behavior setting 18.5, high school boys basketball game (Reproduced from Barker (1968, p. 99))

Barker and his associates filled out data sheets in this same form for each of the 884 behavior settings. The implication is that these attributes of behavior settings could be rated on the same scales in all authority systems and for all age groups or combinations of age groups that might occupy them.

In this dissertation we use Barker's concepts of behavior mechanisms but not the many other items provided for in Figure 1; we shall comment, therefore, only on the behavior mechanisms. The basketball game is a very "rich" setting in terms of behavior mechanisms; four of the five listed in the right hand column are given ratings of 7 to 9; the maximum possible rating is 10. Affective Behavior and Talking are given ratings of 9; it is not clear where the one point has been deducted.

It will be helpful here to quote Barker's own description of the rating scales:

> "Behavior Mechanisms: Rating Scales
> The standing behavior patterns of behavior settings have been rated on five variables called behavior mechanisms: Affective Behavior, Gross Motor Activity, Manipulation, Talking, and Thinking. The extent to which these mechanisms occur in a behavior setting is judged by a rating method similar to that used with the action patterns. There are three subscales.
>
> (1) Participation Subscale: The degree of occurrence of the mechanism in the standing behavior pattern of the setting, it is rated according to the following scale:
>
> 0 The mechanism occurs in less than 10 percent of the OT of the setting.
> 1 The mechanism occurs in 10 to 33 percent of the OT of the setting.
> 2 The mechanism occurs in 34 to 66 percent of the OT of the setting.

3 The mechanism occurs in 67 to 90 percent of the OT of the setting.
4 The mechanism occurs in more than 90 percent of the OT and the setting.

Example: Talking, including singing, was judged to be involved in 34 to 66 percent of the total OT of the setting Primary School Music Classes; hence, it was rated 2 for the mechanism Talking.

(2) Tempo Subscale: The maximum speed with which the mechanism normally occurs in the setting; the unusual, abnormal burst of speed is not rated. In rating tempo and also intensity, consider the average maximum speed or degree of occurrence in the setting. An analogy may help here: a single index of the height of the range of mountains is the average height of the peaks of the range. A curve representing the tempo or intensity of a behavior setting is in most cases a fluctuating curve, and the "height" of the curve can similarly be indicated by a single index—the average height of its peaks. This is what is meant by the maximum normal speed and intensity.

In the behavior mechanism ratings, ratings of the peak speeds with which the mechanisms occur (during the time that they do occur) and ratings of the peak intensities with which they occur (when they do occur) are added to ratings of the extent to which the mechanisms occur in the standing patterns of behavior. These are not, therefore, "volumetric" ratings. A mechanism that is expressed in only one percent of the OT of the setting but that is expressed at top speed and intensity when it does occur receives a rating only 40 percent less than if it occurred at those high speeds and intensities during the whole time, i.e., it would be in the latter case receive a rating of 10 and in the former case a rating of 6. There are other combinations that add to 6; e.g., the mechanism occurs in 100 per cent of the OT (rating 4) at average speed (rating 1) and average intensity (rating 1). Tempo is rated as follows:

0 When the mechanism occurs, its maximal normal speed is slow; reaction times are long.
1 The maximal normal speed of the mechanism is in the median range, neither fast nor slow.
2 The maximal normal speed of the mechanism is above the median range.
3 The maximal normal speed of the mechanism is near the physiological limit.

Example: In the setting Pearson Dairy Route, the maximal speed of Gross Motor Activity is regularly more rapid than the median rate of gross motor movement, the milkman hurries, rated 2. High School Boys Basketball Practice involves Gross Motor Activity at top speed, rated 3.

(3) Intensity Subscale: The usual, maximal rate of energy expenditure via the mechanism, rated as follows:

0 When the mechanism occurs, the maximal normal rate of energy expenditure is very low.
1 Maximal normal energy expenditure is in the median range.
2 Maximal normal energy expenditure is above the median range.
3 Maximal normal energy exerted is near the physiological limit.

Example: The events in the High School Track Meet regularly involve a maximal energy expenditure via Gross Motor Activity, rated 3.
A behavior setting mechanism rating is the sum of the rating on these three subscales. The range of ratings is from 0 to 10 (Barker, 1968, pp. 66-68).

Affective Behavior and Talking are more characteristic of the audience (zone 2) than of the performers (zones 5/6 and 4) and the audience probably justified ratings of 3 for tempo and 3 for intensity on both mechanisms. If so, participation was rated 3 (the mechanisms occurred in 67 to 90 percent of the OT of the setting) rather than 4 (the mechanisms occurred in more than 90 percent of the OT). If the audience alone had justified a rating of 4 (say 91 percent of audience OT) and the performers alone (including cheerleaders, band members, and popcorn salesmen who operated mainly during intermissions) a rating of 1 or 2, the performers could have brought the percent of total OT down to 90 or less.

Gross Motor behavior is primarily an activity of the players, who would no doubt justify ratings of 3 on tempo, 3 on intensity, and 4 on participation (whenever the ball is in play) for a combined rating of 10. The ratings of 3 on tempo and 3 on intensity are applied to the setting as a whole, which gets a total of 6 points on these two subscales.

While other performers in zone 4 (referees, cheerleaders, band members, popcorn salesmen) spend some time in gross motor activity, the much more numerous audience gets a rating of 0. Hence, the setting as a whole is rated 1 on participation (10 to 33 percent of total OT); the result is a combined rating of 7 on Gross Motor Activity.

As to Manipulation, the players must handle the ball with maximum speed and intensity, giving the setting a combined rating of 6 on these two subscales. The players would probably rate 4 on participation whenever the ball is in play; band members and popcorn salesmen might also get a positive rating on participation. As yelling rather than hand-clapping is the principal form of applause at basketball games, the audience was probably rated 0 on Manipulation (the mechanism occurred in less than 10 percent of audience OT). For audience and performers together, the percent of total OT in which manipulation occurs is probably between 10 and 33, yielding a rating of 1 on participation and a combined rating of 7 on manipulation for the setting as a whole.

Finally, the basketball setting has been given a rating of 4 on Thinking. Barker defines this mechanism as follows:

> Thinking: Problem solving and decision making: does not include routine motor behavior or emotional behavior.
> Participation: Per cent of the OT of a setting occupied with problem solving or decision making.
> Tempo: Maximal speed with which problems are normally solved and decisions made.
> Intensity: The maximal level of Thinking that typically occurs in the setting.
> Thinking OT is reduced in proportion to the length of time it takes to carry out decisions that are made.

> The listeners at a sermon or lecture think to the degree that they evaluate and criticize what is said; to the degree that they only record what is said, they do not think.
> Participation is low, 0-9 per cent, (a) if few participants make decisions or (b) if the participants could be thinking about something else most of the time (Barker, 1968, pp. 69-70).

As only the players, referees, and coaches are seriously involved in problem solving and decision-making and account for less than 10 percent of the total OT, the setting must have been rated 0 on participation. The tempo of decision-making by the players would probably justify a rating of 3, which would also apply to the setting as a whole. It is not clear what is meant by the maximal level of Thinking; at any given moment a player is usually faced with two or three simple alternatives (which direction to move, which of two team mates to throw the ball to, and so on) which do not involve a high degree of cognitive complexity; a rating of 1 would imply that the level of Thinking is "in the median range" of everyday cognitive activity, and would account for the combined rating of 4 on Thinking for the setting as a whole.

Barker's concept of the zones of a behavior setting may be clarified by Table 2, adapted from Barker and Schoggen (1973, p. 37). Some behavior settings contain only two or three occupied zones; for example, each behavior setting in Genotype 58, Elementary School Basic Classes, contains only a teacher (zone 6, single leader) and pupils (zone 3).

According to Barker and Wright (1955, 1971) and Barker (1965, 1968), a behavior setting occurs at a specific, identifiable place and time, is composed of people, objects, and behaviors, and is unique in the sense that its parts form a pattern which differentiates it from

Table 2. Penetration zones of behavior settings: their functions, power, human components and examples[a]

Penetration zone	Functions	Power	Human components	Examples
6	Control and implementation of program	Direct control of entire setting	Single leaders	Club president presiding at meeting
5	Control and implementation	Direct, but shared, control of entire setting	Multiple leaders	Team captain conferring with coach
4	Joint control (with zone 5 or 6) and implementation of subsystems of program	Direct, shared	Factors (functionaries, assistants, etc.)	Church organist playing for worship service
6-4	Control and operation of program	Direct control of entire setting	Operatives	Lawyer or his secretary answering query of clients
3	Implementation of major goal	Indirect control of most of setting	Members (customers, clients, etc.)	Store customer making purchase
2	Implementation of minor goal	Some influence on part of setting	Spectators (audience, invited guests, etc.)	Parade viewer watching parade
1	No functions	Almost no power	Onlookers (loafers, etc.)	Infant accompanying mother in grocery store
0	Recruiting and dissuading potential inhabitants	Region of influence external to setting	Potential inhabitants	Potential guest reading invitation

[a]Source: Adapted from Table 2.4 in Barker and Schoggen (1973, p. 37).

other settings. Behavior settings are also person-neutral in the sense that the pattern of behavior in a setting does not depend on any specific individual. For example, in a grocery store, certain kinds of selecting, buying, and selling behaviors occur independently of who is in the setting. Furthermore, there is a fit between the physical environment in which behavior takes place and the recognized or observed pattern of behavior, e.g. the fit between the arrangement of a school auditorium and stage and a play the students may be presenting.

The sequence of events in a behavior setting is called its program; when two or more settings have the same program, they are said to belong to the same genotype. The behavior settings within a genotype can easily exchange personnel with little or no interruption in the setting programs.

A very brief review of the diversity of research in which behavior settings have been used is in order here as it will give further evidence of their stability as basic units in a comprehensive system of social accounts.

Wicker (1972) discusses several psychological theories relating to operant learning, observational learning, behavior setting theory and social exchange to show their convergence. He observes that the behavior setting is a useful unit for the study of man-environment relationships--but argues that research on behavior settings should go beyond static description. He refers to the social exchange theory of Thibaut-Kelley (1959) which focuses on a two-person relationship in a reward-cost framework. Wicker's opinion is that this reward-cost framework can be used in dealing with the dynamics of how a person selects a behavior setting and a behavior setting selects persons simultaneously. For each theory that Wicker discusses research problems relevant to environmental planning and design are suggested.

Wicker (1968) in investigating undermanning and performance in behavior settings of large and small high schools thinks of undermanned settings as those in which manpower needs exceed manpower supply. Performance in terms of positions of responsibility held in settings is reported as higher in undermanned settings than in overmanned settings.

Wicker (1969b) finds that from self-report data on participation and church records of attendance and contributions, members of small churches show greater support for church activities than members of large churches; in both small and large churches, established members show greater support than new members.

Wicker (1969a) comes to the conclusion that cognitive complexity as a function of frequency and intensity of interaction has a higher score among students in small schools than similar students in large schools.

Gump (1971a) believes that designers can affect the quality of life through the environments that they create whether the environment is a park, plaza, square or a subway. He argues that behavior in such environments can be analyzed with new precision by using behavior settings as a standard unit in environmental research.

Gump (1971b) emphasizes the fit between the physical environment (milieu) and the behavioral environment and argues that the evaluation of a milieu should be based on its synomorphy (similarity in shape) with the standing patterns of behavior. His view is that greater advances could come through collaborative research efforts of designers and behavioral scientists.

If behavior settings are adopted as sampling units, one justification for this is that behavior settings are stable entities with both time and space loci; behavior settings are also relatively stable across cultures. Thus, Barker and Wright were able to identify, describe, and catalogue the behavior settings of Midwest, Kansas and Yoredale, Yorkshire (Barker and Barker, 1961a, 1961b; Barker and Wright, 1971), and (Barker, 1963) reports on page 26 that:

> Our work in Midwest, Kansas and Yoredale, Yorkshire has demonstrated that behavior settings can be identified and described reliably without an explicit theory and by means of a variety of survey techniques. This is of some importance, we think, as an indication that behavior settings are tough, highly visible features of the ecological environment.

Behavior settings may play a role in the social sciences analogous to those of cells and atoms in the biological and physical sciences. As Barker (1963) points out, the biologist studies cells and the physicist studies atoms which consist of bounded and internally patterned units that are frequently arranged in precisely ordered arrays and sequences. Behavior settings also possess this kind of order in the preperceptual environment (i.e., the environment which exists independently of any observer).

In school size research, Willems (1967) in a study of the sense of obligation of high school students to nonclass school activities, investigated "reasons for or pulls toward" attending selected nonclass activities for both marginal and regular students in small and large schools. The marginal students Willems defined as those poorly suited to success in a school environment and the regular students as those better suited to success in a school environment. In two phases of Willems' study, 1961 with N = 40 and 1965 with N = 80, he found that marginal students in small schools reported as much sense of obligation as regular students, while marginal students in large schools reported little, if any. In this study by Willems and in Barker and Gump (1964) it is reported that students in small schools functioned more often as performers in nonclass activities than did students in large schools.

Gump (1971a) reports a study by the Willems-Le Compte research team in health care delivery systems for a rehabilitation hospital. According to Gump (1971a), the Willems-Le Compte study showed that a few behavior settings--the wards, physical therapy, hallways, and occupational therapy--held 93 percent of patient activities and 89 percent of their time, or, about 90 percent of the patients' behavior took place in some four percent of the hospital's behavior settings.

If social accounting is to affect the quality of life, the need for time-budgets over a comprehensive range of activities cannot be overemphasized. Behavior settings stand as basic units for observing time-budgets of individuals. One psychologist has rightly pointed out that:

> . . . men spend their lives in one ecological unit, one behavior setting, or another. They inhabit restaurants, offices, traffic-ways, parks, school rooms, drug stores and markets. The quality of their existence can be markedly affected by the quality of these units (Gump, 1971a, page 50).

Also, Gump (1971b, p. 134) notes that:

> The conviction of the ecological psychologist is that people live out their lives in a sequence of environmental units; experience in these settings is life. If the quality of experience is good, life expands; if it is bad, life diminishes.

It is clear from this brief review that the relative stability of behavior settings across cultures and their time-space characterizations are essential qualities which favor their use as sampling units. If social programs intended to improve the quality of life are focused on age-specific populations then behavior settings frequented by these populations are natural, environmental units in which to evaluate the performance of such programs.

For the reader interested in furthering his knowledge of behavior settings, their nature is further clarified in Wicker (1979) which is a convenient introduction to the field of ecological psychology. In this book, Wicker discusses methods used in conducting behavior setting surveys and the uses of behavior setting surveys in the documentation of the community life of residents, in assessing social impact, and in organizational analyses. The self-regulating processes in behavior settings are also discussed. In their preface to Wicker (1979), Irwin Altman, Daniel Stokols, and Lawrence Wrightsman portray the interdisciplinary nature of research with behavior settings as follows:

> The study of environment and behavior has shown a rapid development in recent decades; we expect that interest in this field will continue at a high level in the future. As a young and informative area, it has many exciting qualities. For example, the analysis of the relationship between human behavior and the physical environment has attracted researchers from many fields in the social sciences, such as psychology, sociology, geography, and anthropology, and from the environmental design fields, such as architecture, urban and regional planning, and interior design. The multidisciplinary character of this field has led to an atmosphere of stimulation, cross-fertilization, and yes, even confusion and difficulty in communication. Furthermore, because of the diversity in intellectual styles and goals of its participants, research on environment and behavior has as often dealt with applied, real-world problems of environmental design as it has treated basic and theoretical issues (p. v).

Further insight into the field of ecological psychology can also be gained from Barker and Associates (1978), particularly Chapter 5 in which Barker describes the interdisciplinary endeavor needed to develop an eco-behavioral science.

2. Karl Fox and Associates on social accounts

The system of social accounts proposed by Fox would yield estimates of equivalent dollar values of behavior inputs as well as equivalent dollar values of rewards. Thus, the income concept useful in such a system would be Total Income as defined in Fox and Van Moeseke (1973), reprinted as Chapter 3 in Fox (1974).

Total Income is closely related to the Full Income concept of Gary Becker (1965) in his "Theory of the Allocation of Time." Fox arrived at the Total Income concept independently of Becker by combining Talcott Parsons' (1968) concept of generalized media of social interchange with Roger Barker's theory of behavior settings and the economists' theory of consumer behavior. This synthesis was presented as "Operations Research and Complex Social Systems," Chapter 9 in Sengupta and Fox (1969).

Our own interest in behavior settings as basic units in a comprehensive system of social accounts derives from Fox (1974), Social Indicators and Social Theory; despite its title, it is actually a book on social accounts. Fox emphasizes behavior settings as basic units in social accounts, and in Chapter 3, Fox and Van Moeseke establish rigorously the derivation and implications of a scalar measure of total income. Felson (1979) in his review of Fox (1974) credits Fox with a major breakthrough. Recently, Ghosh (1979) constructed a pilot set of social accounts based on the Fox-Van Moeseke total income approach. We have also jointly expressed our interest in behavior settings as basic units in a system of social accounts in Fox, Ollor, and Ghosh (1979) under the rubric: "Purpose and Predictability in the Environment of Human Behavior."

Other extensions have been made by Prescott (1979a, 1979b) and by Sengupta (1979a, 1979b, 1979c, 1979d). Prescott (1979a) examines some measurement and conceptual problems that will arise if behavior settings are used as units of observation in a system of social accounts. Prescott (1979b) looks at the spatial and temporal problems involved in developing social accounting systems. He discusses time use data in the private enterprise authority system and gives a description of the SRC (Survey Research Center) system for classifying the use of time by American adults in 1975-76, discusses time-and-money expenditure relations, examines the relation of economic variables to occupancy time, and develops time accounting analogs to the GNP accounts. While treating spatial units of aggregation in economic accounts, Prescott also discusses behavior settings and units of spatial aggregation for the Barker authority systems.

Sengupta (1979a) uses interdependence and structural analysis to examine complementarity and substitution relationships of behavior settings, as well as their variety and their erosion overtime. He introduces conveniently the Slutsky effects of economic value theory and shows how this fundamental equation of value theory changes if the prices associated with behavior settings are not transactions prices but are subjectively determined. Sengupta (1979a) also uses the bilinear model to analyze the input-output processes that exist in behavior settings considered as microstates.

Sengupta (1979b) discusses the structure, stability, and efficiency of the distribution of behavior capacity in a community. He uses a production and transactions framework as the basic tool and characterizes the distribution of individuals and their welfare in the social ecosystem.

Sengupta (1979c) compares Becker's (1965) model and the Fox-Van Moeseke model and generalizes the Fox-Van Moeseke model using a general equilibrium formulation.

Sengupta (1979d) illustrates the concepts of adaptation, diversity, and stability in team decision situations comparable to behavior settings and their implications for using information in models of environment and human behavior.

B. Questions Engaged in this Study

This study is the result of two and a half years of participation on a five year research project on the Measurement and Valuation of Social System Outcomes whose objectives were stated as follows:

(1) To contribute toward an integration of theory, methods, and data across portions of several social sciences; (2) to provide a comprehensive framework for social accounts and social data systems at all levels from small communities to the world as a whole; (3) to demonstrate the usefulness of this framework by applying it to a specific region; (4) to lay the theoretical and mathematical groundwork for dynamic models that could be implemented using the proposed new concepts and data systems; and (5) to show how recent developments in information theory could be employed in the valuation of existing and proposed new social data systems relative to the needs of specific categories of decision-makers (Fox, 1979b).

Fox (1979b) sees Barker's concept of behavior settings as providing the basis for the desired integration of theory, methods, and data:

> The interests of several disciplines converge in behavior settings. All roles are played in them; all organizations are composed of them. Felson (1979) asserts that all sociologically interesting phenomena involving direct physical contact between persons occur in behavior settings, and that they appear to be ideal units for describing and modeling social processes. Behavior settings in nonmarket organizations are empirically valid analogs of the economist's markets. Small group phenomena occur in behavior settings; they can be viewed from the standpoints of group dynamics, transactional analysis, game theory, and the theory of teams. Kurt Lewin's concept of an individual's life space remains intact as the means by which a behavior setting secures

> the behavior appropriate to it.
>
> Each individual in a setting can also be viewed as an organism in an environment-organism-environment continuum or E-O-E arc, a conception Barker (1968, pp. 137-139) attributes to Egon Brunswik. Brunswik used the E-O-E arc as a basis for classifying representative schools and problems of psychology; since Barker's ecological psychology, with behavior settings as a focal concept, encompasses the whole E-O-E arc plus environmental phenomena which shape and transmit influences from the termination of one arc to the origins of others, links between other social sciences and psychology can be established, tested, and evaluated in a behavior setting context.

Fox, (1979b) also sees behavior settings as providing a basic unit of observation and measurement for social accounts and social data systems at all levels from small communities to the world as a whole. He believes that, in principle, social accounts based on behavior settings can be superimposed on existing economic data systems for establishments, firms, and industries without distorting or impairing the usefulness of these systems and the national income and product accounts which are based on them.

The national income and product accounts reflect at least 50 years of cumulative development. Their structure is well-defined and well documented. The accepted unit of account (in the United States) is dollars and most of the current human effort used in producing the national product is rewarded in actual dollars.

The phrase "social accounts" as used by Fox, Juster, and other participants in the recent Social Science Research Council (SSRC) Workshop on social accounting systems does not imply an agreed-upon structure or a set of tables waiting to be filled in; sometimes the phrase is used to include any or all social data systems that are sufficiently well-defined that the individual entries must sum to a control total. Thus, the SSRC workshop papers by Stone and Land dealt with demographic accounts in which the accounting units are persons, the individual entries are numbers of persons in specified age groups, and changes in population from year to year must be "accounted for" in terms of births, deaths, immigration, and emigration.

Tables showing the allocations of time of a sample of adults based on time-use diaries for one or more 24-hour days are sometimes referred to as time-use accounts. The unit of account is person-hours and the accounting feature is that time spent on the various activities must sum to 24 hours per person per day.

The sociologists and social psychologists at the SSRC Workshop were generally opposed to the idea of imputing dollar values to person-hours except in gainful employment. However, they were enthusiastic about the descriptive value of time-use accounts based on samples of behavior settings, or samples of households, or (if possible) both.

As economists, Fox and Juster had fewer reservations about imputing dollar values to human time expended in nonmarket activities.

The national income and product accounts are very much concerned with flows of money and materials. Barker essentially ignores money and materials (since they do not "behave"). Instead, he focuses on the observable behavior of the people in the settings. If the setting is a factory assembly shop from which customers and loafers are excluded, every person in the setting is being paid actual dollars for making behavior inputs required by the production process. The wages and salaries received by these persons (though ignored by Barker) are viewed by Fox as payments for the four categories of behavior inputs they supply to the setting. The accounting feature of this approach is that earnings accounted for by these behavior inputs must sum to total earnings.

A job analyst from the U.S. Manpower Administration would also focus on the observable behavior of the workers in the assembly shop. He would rate each distinct kind of job according to the demands it placed on the worker, including strength required, the level of skill involved in handling or shaping materials, the complexity of relations with other workers, and the complexity of the decisions to be made on the basis of data (comparing, measuring, computing areas and material costs, or whatever). On the basis of his observations, he would classify the job as one of 20,000 or so occupations in the Dictionary of Occupational Titles (DOT); the DOT and its Supplements list for that particular occupation a vector of ratings, four of which we believe correspond rather closely to our four categories of behavior inputs.

This dissertation addresses the question: How can Barker's data on behavior settings be linked to official data systems on occupations, earnings, and related aspects of gainful employment? To the best of our knowledge, no economists other than Fox and his associates have attempted such a linkage, and Barker (in a March 25, 1980 letter to Fox), indicates that Fox's recent manuscripts "reveal a future for behavior settings that I have been unaware of". . . i.e., a future as a basis for social accounts and social data systems.[1] The implication is that Barker and his associates have never attempted such a linkage either.

This dissertation is a first attempt at the desired linkage. Our starting point is in Barker's data and our destination is in the 1970 Census data on earnings and related variables in each of an exhaustive set of 460 civilian occupations. No direct route is feasible. Instead, we find it necessary first to link Barker's data on behavior mechanisms with ratings of worker functions in the Dictionary of Occupational Titles (DOT) and second to link the DOT ratings with Census variables on earnings, median years of schooling, and median age of workers in the corresponding occupations.

If our approach to social accounts is taken seriously, statistical agencies will eventually have to develop definitions, units of measurement, field methods, and sampling procedures which combine elements of

[1]In his March 25, 1980 letter, Barker expresses enthusiasm for Fox's efforts in this direction:

> . . . it occurs to me that sometime down the road it would be desirable if you would assemble a seminar or conference of some young ecological psychologists and social systems accountors for mutual education. I know of a few of the former who I think would be interested. This would aid in breaking down the language barrier which you quote Bertram Gross as seeing to be essential, as I know from experience.
>
> . . . I can say that your comprehension and use of behavior settings is in basic agreement with mine.
>
> . . . of one thing I have no doubt: what you are doing is of fundamental importance. It is exciting and satisfying to see one's own meager achievements magnified by the insights of others.

the Barker, DOT, and Census systems and adapt them to the requirements of the comprehensive accounting and data system as a whole. If and when such a system is implemented, it should be possible to estimate structural relationships and test hypotheses involving variables included in the system. However, in this dissertation we shall have to make a number of assumptions which future research workers may be able to replace with estimates based on improved data.

Barker's (1968, pp. 211-228) descriptions of the programs of behavior setting genotypes correspond closely to the definitions of job titles in the Dictionary of Occupational Titles - Handbook for Analyzing Jobs (DOT-HAJ) system. For example, Barker's (1968) program for Genotype 15, Banks, reads as follows:

> President (6) manages all operations, makes loans, gives financial advice, provides credit information; vice-president (4) makes loans, sells insurance; cashier (4) cashes checks, receives deposits, provides access to safe deposit, keeps records; clerks (4) engage in office routines; bank examiners (4) come at intervals to examine the routines, the assets and liabilities of the bank in relation to legal standards; customers (3) deposit and withdraw money, arrange for or pay back loans, seek advice, use safe deposit boxes, and converse (p. 212).

The numbers in parentheses in the above program are what Barker refers to as "zones": (6) denotes zone of single-leadership, while (5) denotes zone of joint-leadership, and (4) denotes the zone for the active-functionary. "President (6)" for example implies that the Bank President is the chief executive or single leader of the bank operations. Collectively, zones 6, 5, and 4 occupants are called the "performers" of the setting.

The Dictionary of Occupational Titles (1965) gives the title definition for a bank cashier as:

> Bank Cashier (banking) 186.168. Directs bank's monetary programs, transactions, and security measures in accordance with banking principle and legislation: Coordinates program activities and evaluates operating practices to insure efficient operations. Oversees receipt, disbursement, and expenditure of money. Signs documents approving or effecting monetary transactions. Directs safekeeping and control of assets and securities. Approves loans and participates as member of committees concerned with loaning and customer service functions. Directs accounting for assets, and maintains specified legal cash reserve. Reviews financial and operating statements, and presents reports and recommendations to bank officials or board committees. Maintains financial and community business affiliations to broaden bank's services and develop new business. When supervising stock transactions may be designated as Stock Cashier (p. 41).

By using the ratings of worker functions in the Handbook for Analyzing Jobs (1972, p. 73), it was possible to rate the definitions of titles in the Dictionary of Occupational Titles (1965) on such worker functions as coordinating, supervising, manipulating, etc. Furthermore, the Supplements to the Dictionary of Occupational Titles (1966 and 1968) allowed us to match each job that had a title definition in the DOT with such characteristics as physical demands of the job, working conditions, and training time required for the job.

Since Barker's (1968) programs of behavior setting genotypes include both market and nonmarket activities, it seems clear that both market and nonmarket activities could be rated by job-analysis techniques. In this study, however, we restrict ourselves to the labor market. But this approach opens up the way to rating nonmarket activities with the same job analysis techniques.

We have already described Barker's scales for rating the tempo, intensity, and extent of the use of various behavior mechanisms in a setting. It appears to us that these mechanisms are inputs or contributions to a setting supplied by its occupants. Three of these mechanisms, Thinking (problem solving and decision-making), Affective Behavior, and Manipulation (use of the hands) seem to correspond to the "domains" described in three well-known handbooks of educational objectives by Bloom, ed. (1956) who talks of the cognitive domain, Krathwohl et al. (1964) who discuss the affective domain, and Harrow (1972) who discusses the psychomotor domain. A fourth mechanism, Gross Motor Activity, evidently corresponds to a fourth domain intensively studied by the physiologists Durnin and Passmore (1967) in their book Energy, Work, and Leisure. We therefore decided that behavior can be grouped exhaustively into four categories, namely inputs of cognitive behavior, affective behavior, psychomotor behavior, and gross motor behavior. Belcher (1974, p. 174) in his book on Compensation Administration also uses such factors as mental effort, physical effort, mental skill, manual skill, and several others in establishing point values which aid in setting wages and salaries for different jobs. Belcher's factors also seem to correspond to our four exhaustive groupings of behavior inputs.

Having established support for four groups of behavior inputs, the next question was how to attribute equivalent dollar values to these inputs. The DOT-HAJ system provided reasonable proxies for the behavior inputs used in gainful employment. Therefore, using a series of assumptions, we made exploratory attempts to use the job attributes reported in the DOT-HAJ system as variables in some regression analyses involving U.S. 1970 Census variables such as earnings, median years of schooling, and median age in arriving at proportions of earnings attributed to cognitive, affective, psychomotor, and gross motor inputs.

In this study, we estimate equivalent dollar values of behavior inputs used in gainful employment in a preliminary set of social accounts for the U.S. and the Des Moines Bureau of Economic Analysis (BEA) Economic Area and its subareas. These accounts also embody concepts similar to those of the national income accounts and provide weighted averages of relevant DOT and Census variables that will be needed in the intended social data systems.

In the Des Moines BEA Economic Area and its subareas, the approach taken in this study adds something to our knowledge of the region's labor market by explaining some of the earnings differentials between occupations on the basis of the input vectors required. The approach may be relatively much more important to researchers in attributing dollar values to nonmarket activities based on the estimated market values of the behavior inputs used in those activities. However, this will require cooperation between economists, sociologists, social psychologists, and physiologists since each step in the linkage of data systems used in this study poses questions for further research.

II. DATA USED

Barker and his associates made community-wide behavior setting surveys for only one town in the United States (Midwest, Kansas) and one in England (Yoredale, Yorkshire). They made at least three such surveys for Midwest (1951-52, 1954-55, and 1963-64) and at least two for Yoredale, Yorkshire (1954-55 and 1963-64); the 1954-55 and 1963-64 surveys were coordinated to permit place-to-place comparisons between the two towns in both years and to measure changes over time in each town separately.

Fox and his associates have confined their detailed empirical work to the United States, so only the Midwest surveys are relevant to our attempts to link Barker's concepts and findings to official data systems. Barker and Wright (1955) made some use of 1950 Census data on Midwest as background information for the reader's benefit but did not use it in their actual surveys. Barker and Gump (1964) noted that most of the zone 4, 5, and 6 roles performed by students of Midwest High School, whether paid or unpaid, were standard occupations in the American society and could be assigned code numbers from the Dictionary of Occupational Titles (2nd ed., 1949); however, they did not relate their own concepts (e.g., behavior mechanisms) to the DOT ratings of strength, reasoning ability, and other requirements imposed on workers by specific occupations.

During 1977-79, Fox, Ghosh, and Ollor, ably assisted by Shu Y. Huang, constructed one data set based on 1970 Census information on occupations and earnings and another based on the ratings assigned to <u>worker functions</u> and <u>worker traits</u> for corresponding occupations in the <u>Dictionary of Occupational Titles</u> (3rd ed., 1965) and its Supplement (1966). These sets were merged to permit linkage of the DOT variables with Census variables on earnings, education, median age, and other attributes of workers in each of an exhaustive set of civilian occupations. There were from 441 to 460 such occupations in successive revisions of the data sets; the upper limit is set by the Census categories, some of which contain two or more of the 14,000 DOT occupations. In fact, a few of the Census categories are labeled "miscellaneous" or "not specified" or "not elsewhere classified," and some of them must contain literally hundreds of DOT occupations which involve a few workers performing a highly specialized task in a particular industry.

In order to arrive at a preliminary set of social accounts in which dollar values are imputed to behavior inputs, it was necessary to make rather arbitrary (but reproducible) assumptions in establishing some of the required linkages. We hope that national statistical agencies will be motivated to collect the data and support the research that will be needed to establish these linkages on a fully satisfactory basis. In this dissertation, however, we can only describe what we have done.

A. The Handbook for Analyzing Jobs (HAJ)

The HAJ (1972, p. 233) refers to the following seven of the eleven aptitudes in the Handbook as "cognitive": intelligence (G), verbal (V), numerical (N), spatial (S), form perception (P), clerical perception (Q), and color discrimination (C). The other four attributes are motor coordination (K), finger dexterity (F), manual dexterity (M), and eye-hand-foot coordination (E)--all of which seem to be "psychomotor" capacities. Thus, the HAJ supplies us with data on cognitive and psychomotor capacities.

Barker's five behavior mechanisms, gross motor, manipulation, thinking (decision-making), talking, and affective behavior, correspond to several in the HAJ. Four of Barker's behavior mechanisms which appear to correspond to four HAJ attributes are gross motor, psychomotor (manipulation), cognitive (thinking), and affective behavior. The DOT, like the HAJ, describes worker functions in terms of job complexity in relation to "data," "people," and "things." In our opinion, these DOT-HAJ variables are reasonable proxies for three of Roger Barker's behavior mechanisms.

The DOT's "data" variable is a proxy for cognitive demands on the worker because it explains what the worker does in relation to data (information) processing and this involves thinking and decision-making. The DOT's "people" variable explains worker-functions in relation to people which involve emotional demands; hence, we take it as a proxy for affective behavior. Lastly, the DOT "things" variable explains what the worker does in relation to things and this involves manipulation (work with the hands) in using tools, operating machines and handling materials, hence, it is a proxy for psychomotor demands on the worker. The fourth category, namely gross motor, is assumed independent of any learned skills and represents (shear) capacity to burn calories and do work in the physicist's sense.

We assume that the four domains, cognitive, affective, psychomotor, and gross motor, are exhaustive and therefore, lose talking as a separate behavior mechanism. The assumption which permits us to discard talking as a behavior mechanism is that talking is combined appropriately with the other four to communicate ideas or emotion and to coordinate the activities of two or more persons in settings which emphasize manipulation and/or gross motor activity.

The correspondence between Barker's behavior mechanisms and the specified DOT variables seem close enough for the exploratory purposes of this dissertation, but more research will be needed on them before they are used in connection with any official data systems.

B. The Dictionary of Occupational Titles (DOT): Third Edition (1965)

The DOT data include some variables on working conditions. The DOT also indicates that a particular occupation requires certain levels of GED (general educational development) and SVP (specific vocational preparation) and certain levels of aptitudes--general, verbal, and numerical. The second three digits of the DOT code indicate where a particular occupation stands in relation to three "hierarchies" of worker relations to "data," to "people," and to "things."

The census data on each occupation include variables for male workers on 1969 earnings, median years of schooling, median age, hours worked per week, percent of government workers, percent of black workers, and a few other items. The same variables are presented for female workers.

One assumption made to permit analysis involving both DOT and census data sets is that the census workers had the qualifications the DOT implied they should have had. The DOT includes about eleven aptitudes of which general, verbal, and numerical are three. One or more of these aptitudes should have positive "shadow prices" in any given job. So should GED, which is usually associated with years of schooling, and SVP. The DOT also includes information on temperaments and interests which are independent of the question whether an individual can do a particular job. If the individual is not interested in the job or dislikes the pattern of work because it is too monotonous or too hectic, the DOT asserts that he will not stay in it very long. By anticipating this, the employer avoids the costs of too rapid turnover and the worker avoids a job that is not "right" for him.

Up to the time of the 1970 census, most U.S. males were in the labor market continuously from school-leaving age to retirement. We would expect that those with higher levels of work-related skills would generally move into jobs which pay for those skills.

Some DOT variables which should affect annual earnings include working conditions: Y_1 (heaviness of work), Y_2 (indoor versus outdoor work), and Y_3 (work environment hazardous or unpleasant). Higher values of Y_1, Y_2, and Y_3 imply that the work is heavier, more of it outdoors, and more of it unpleasant and/or dangerous, respectively. Hence, we would expect that higher values of Y_1 and Y_3, and possibly of Y_2, would require a wage premium to attract workers of any given levels of GED (Y_4), SVP (Y_5), and other attributes.

In our data set, the levels of Y_6 (general learning ability, G); Y_7 (verbal aptitude, V); Y_8 (numerical aptitude, N); Y_{13} (relationship to "data"); Y_{14} (relationship to "people"); and Y_{15} (relationship to "things") most favorable to earnings are 0 or 1, and values of 2, 3, 4, 5, are successively less favorable to earnings, X_1. In contrast, higher values of Y_4 and Y_5 are more favorable to earnings as they imply higher levels of reasoning ability (usually backed by more years of schooling) and longer periods of specific vocational preparation.

The following properties hold for these variables in the DOT data set. GED and SVP are logically independent but seem to be positively correlated in practice. G (general learning ability), V (verbal aptitude), and N (numerical aptitude) are highly correlated with each other, and, of course, with their simple average $Y_9 = \frac{G + V + N}{3}$. Y_{13}, "data", has a high correlation with GED. Y_{13} has a moderate positive correlation with Y_{14}, "people," and a very small negative correlation with Y_{15}, "things."

The following regression equation is instructive:

$$Y_{14} = 7.49 + 0.235Y_{14} - 0.326Y_{15}$$
$$(0.20)\ (0.027)\qquad (0.026)$$
$$\bar{R}^2 = 0.3725. \qquad (2.1)$$

Equation (2.1) says that Y_{14}, "people," has a substantial positive relationship to Y_{13}, "data," and a substantial negative relationship to Y_{15}, "things." In other words, jobs involving complex relations to people involve above-average levels of cognitive complexity and little or no skill in dealing with "things."

Usually, one of the three DOT variables Y_{13}, Y_{14}, and Y_{15} appears to be an irrelevant or "slack" variable with respect to a given occupation. Since $\bar{Y}_{14} = 6.745$, it seems that most jobs involve fairly low-level skills in dealing with people: for example, level 8 (taking instructions, helping), level 7 (serving), and level 6 (speaking-signaling). Sometimes only one variable, Y_{13}, "data," or Y_{15}, "things," will be particularly restrictive. Y_{15} is applied almost exclusively to blue collar occupations in the DOT; most white collar occupations are classified as having no significant relationship to "things." Thus, Y_{15} does not reflect the psychomotor skills of (for example) typists and musicians.

The logical connection between Barker's data and the DOT should perhaps be stated more explicitly. Barker's data are focused primarily on behavior settings and secondarily on the activities of the occupants performing each of the distinct roles involved in their programs. The DOT focuses on the functions performed by the occupants of each role (job) and the attributes which occupants must have to perform the role adequately. The DOT ratings of the complexity of a worker's functions in relation to "data," "people," and "things" in effect look at the program of the work-setting as a whole in terms of the demands it imposes on the workers performing a particular job.

Work on the DOT was begun in the 1930's under a predecessor agency of what is now the U.S. Manpower Administration. The first edition was published in the late 1930's or early 1940's, the second in 1949, and the third (which we used) in 1965. Its purpose was to facilitate the matching of job applicants with jobs on a case-by-case basis in hundreds of local labor markets. Many millions of job referrals have been handled on the basis of DOT ratings of jobs and workers, and the successive editions have taken account of feedback from local offices of the Federal-State Employment Service and also of special studies.

Thus, the DOT ratings are based on intensive observations of real jobs and real workers in a presumably exhaustive array of civilian occupations. Barker's data are based on intensive observations of real performers in an exhaustive array of nonhousehold behavior settings in a real community. To the extent that Barker's performers were gainfully employed, they were carrying out the worker functions described in the DOT and presumably had the worker traits listed in the DOT as necessary for average performance of those functions.

While the DOT is concerned only with paid jobs, the jobs include those of housekeepers, chauffeurs, athletes, musicians, house painters, and others who do for pay what many people do for recognition, recreation, or do-it-yourself economy. Thus, it seems clear that the DOT system could be extended to cover roles performed by amateurs and volunteers in nonmarket organizations, including households. Barker explicitly uses the same data sheet for describing all nonhousehold behavior settings, market and nonmarket alike. While for reasons of policy and research focus Barker did not include household behavior settings in his surveys, it was axiomatic to him that household behavior settings could be described and rated in the same fashion.

Thus, we believe that Barker's approach and that of the DOT are basically compatible and could be made more so in the future.

Since the DOT was designed as a reference book for job placement and vocational counseling and not as a basis for official data systems, it took a great deal of work on our part (Fox, Ghosh, and Ollor) to turn the ratings of 1,000 or more DOT occupations into a data set conformable with the 460 occupations for which data were published in the 1970 Census of Population. This aspect of our work should also be improved upon in the future by the appropriate statistical agencies.

C. The 1970 Census of Population: Special Volume on Occupations and Earnings

A special volume of the U.S. Census of Population, 1970, on occupations and earnings. Series Number PC(2)-7A provided the Census variables on earnings, education, and median age that were linked to the DOT variables.

The variable 1969 average yearly earnings of workers employed 50-52 weeks (our X_1 for males and X_2 for females) was taken from Table

19, pages 368-381 of PC(2)-7A. Table 19 also gave us total persons with earnings, our N_1 for males and N_2 for females.

Median years of schooling of workers in the occupation, our variables X_5 for males and X_6 for females, were taken from Table 5, pages 59-72 of PC(2)-7A. Two other variables of interest, namely percent of workers who have completed 4 years of high school or more, and percent of workers who have completed 4 years of college or more, were also obtained from Table 5.

Median ages of workers in the occupation, which we have labeled X_7 for males and X_8 for females, were obtained from Table 1, pages 1-11 of PC(2)-7A.

The Series PC(2)-7A reports at the top of each of the above tables that the data were based on a 5 percent sample. There were approximately 80,000,000 workers in the experienced civilian labor force, so the U.S. sample includes about 4,000,000 workers spread over 460 occupations and also classified by sex. In most occupations, sampling errors as such must be small; however, errors in occupational classifications could be substantial and a good many workers are assigned to "miscellaneous" or "not elsewhere classified" categories.

III. METHODS EMPLOYED

The statistical method employed in this chapter is ordinary least squares regression. The 460 observations relate to the 460 census occupations that were matched to ratings of job complexity in relation to data, people, and things in the Dictionary of Occupational Titles (DOT) described in Chapter II. The Handbook for Analyzing Jobs (HAJ) also described in Chapter II helped us interpret the ratings in the DOT.

Before we provide a summary definition of variables, we shall comment first on our variables Y_{13} = "data", Y_{14} = "people" and Y_{15} = "things" as well as the variable Y_1 = "heaviness of work".

The Handbook for Analyzing Jobs (1972, p. 73) gives the following structure of worker functions in relation to data, people, and things:

DATA	PEOPLE	THINGS
0 Synthesizing	0 Mentoring	0 Setting up
1 Coordinating	1 Negotiating	1 Precision working
2 Analyzing	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-Signaling	6 Feeding-Offbearing
	7 Serving	7 Handling
	8 Taking instructions-helping	

Lower identifying values are, as a rule, more favorable to earnings than higher values, e.g., 0 is more favorable than 1, and so on, for each of the variables "data", "people", and "things".[1]

For the variable Y_1 = heaviness of work we relied on Durnin and Passmore (1967, p. 47) who grade work in terms of energy consumption as indicated below under "range":

Men (65 kilograms body weight)
(kilocalories per minute)

Type of Work		Range	Midpoint	Y_1
Office: sitting at desk		1.3 to 1.8	1.55	0
Office: standing and moving around		1.5 to 3.3	2.40	0
Industrial:	Light	2.0 to 4.9	3.50	1
	Moderate	5.0 to 7.4	6.25	2
	Heavy	7.5 to 9.9	8.75	3
	Very Heavy	10.0 to 12.4	11.25	4

The columns labeled "midpoint" and "Y_1" have been added for our present purpose.

We assumed that energy expenditure is an appropriate indicator of gross motor activity. On this basis, office (sedentary) work requires about 1.5 to 2.0 kilocalories per minute, light work requires about twice and moderate work about thrice as many, and so on.

Since the Supplements to the Dictionary of Occupational Titles (1966, 1968) actually characterize every job in the DOT as sedentary, light, medium, heavy, or very heavy we used these five ratings on Y_1 to identify

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[1]A fuller discussion of these three variables is given in Appendix A. As a rule, lower identifying values also involve higher levels of complexity; Berwitz (1975, p. 47) implies that this is strictly true for DATA and THINGS and true in a general or approximate sense for PEOPLE.

the heaviness of work. The identifying values of "data", "people", and "things" are also available for every job in the DOT. Berwitz (1975) implies that the DOT covers "the 14,000 basic jobs" in the U.S. economy.

The DOT contains no information on earnings. The 1970 Census provides information on 1969 earnings in each of an exhaustive set of 460 occupations. Obviously, the Census classification system is coarser than that of the DOT. Some Census occupations (e.g. judges or typists) may be represented by only one or two entries in the DOT; in such cases matching Census variables with appropriate values of DOT variables is easy and presumably accurate. However, the 460 Census occupations include about 20 "miscellaneous" and "not elsewhere classified" categories that must contain literally hundreds of DOT jobs; in those cases we inserted what we regarded as reasonable values of the DOT variables, as accurate matching was impossible.

As a result of this matching, our data set consists of 460 observations on each of four DOT variables (complexity of worker functions in relation to data, people, and things; heaviness of work) matched with corresponding observations on each of six Census variables (average annual earnings, median years of schooling, and median age--each of these for male and female workers separately) for the 460 Census occupations.

A. Definition of Variables

Y_{13} = hierarchical level of worker function in relation to <u>data</u>;

Y_{14} = hierarchical level of worker function in relation to <u>people</u>;

Y_{15} = hierarchical level of worker function in relation to <u>things</u>;

Y_1 = <u>strength</u> required in terms of sedentary, light, medium, heavy, or very heavy work (Y_1 is therefore <u>heaviness</u> of <u>work</u>);

Z_{13} = Y_{13} transformed as $(7 - Y_{13})$;

Z_{14} = Y_{14} transformed as $(9 - Y_{14})$;

Z_{15} = Y_{15} transformed as $(8 - Y_{15})$;

Z_1 = Y_1 transformed as $(1 + Y_1)$;

X_1 = 1969 average yearly earnings of male workers employed for 50-52 weeks;

X_5 = median years of schooling of male workers in the occupation;

X_7 = median age of male workers in the occupation;

X_2 = 1969 average yearly earnings of female workers employed for 50-52 weeks;

X_6 = median years of schooling of female workers in the occupation;

X_8 = median age of female workers in the occupation;

V_1 = $(X_1 - \hat{X}_1)$ denotes the residuals from the linear regression of X_1 on Z_{13}, Z_{14}, Z_{15}, and Z_1;

V_5 = $(X_5 - \hat{X}_5)$ denotes the residuals from the linear regression of X_5 on Z_{13}, Z_{14}, Z_{15}, and Z_1;

V_7 = $(X_7 - \hat{X}_7)$ denotes the residuals from the linear regression of X_7 on Z_{13}, Z_{14}, Z_{15}, and Z_1;

V_2, V_6, V_8 are the counterparts of V_1, V_5, and V_7 for female workers;

λ_{psm} = <u>proportion</u> of earnings allocated to psychomotor inputs;

λ_{gm} = <u>proportion</u> of earnings allocated to gross motor inputs;

λ_{cog} = <u>proportion</u> of earnings allocated to cognitive inputs;

λ_{aff} = <u>proportion</u> of earnings allocated to capacity for affective inputs;

z_{cog} = demands on cognitive inputs (in dollars);

z_{aff} = demands on affective inputs (in dollars);

z_{psm} = demands on psychomotor inputs (in dollars);

z_{gm} = demands on gross motor inputs (in dollars);

A few words of explanation are in order concerning our transformations of Y_{13}, Y_{14}, Y_{15}, and Y_1. The transformation of these variables eliminates the values of zero which all the variables had. The minimum value of each of these variables transformed into Z_{13}, Z_{14}, Z_{15}, and Z_1 respectively is now 1. In terms of these Z variables, higher identifying values are more favorable to earnings, e.g. 7 is more favorable than 6, and so on, for each of the variables Z_{13}, Z_{14}, Z_{15} and Z_1. The rationale is that when Z_{13} (or Z_{14}, or Z_{15}) becomes larger, the job is correspondingly more complex. Similarly, when Z_1 has a higher value, the job is heavier in terms of physical effort.

B. Assumptions

In fitting the equations that follow, it is assumed that:

(i) Occupations are described by the complexity of jobs in relation to data, people, and things and by the heaviness of work (the occupation attributes).

(ii) Earnings in occupations depend on the complexity of jobs in relation to data, people, and things and on the heaviness of work.

(iii) The occupation attributes reflect the demands which the average performance of a particular job makes on the average worker in that occupation; individual abilities or performances of workers in a given occupation are widely scattered around such an average.

(iv) "Market prices" for the occupation attributes could in principle be estimated by a regression of average yearly earnings of workers on the complexity of worker functions in relation to data, people and things and on the heaviness of work.

(v) A fuller explanation of earnings in occupations can be obtained if account is taken of those effects of differences in median years of schooling and in median age which are independent of the effects of the complexity of jobs in relation to data, people, and things and of the heaviness of work.

C. Allocating Equations for Assigning Dollar Values to the Behavior Inputs of Male Workers[1]

On the basis of the stated assumptions, an attempt was made to estimate the prices paid in the market for each of the occupation attributes. However, average earnings in different occupations in a given year are influenced by specific demand and supply situations and institutional factors, so we should not expect the variables "data", "people", "things", and "heaviness of work" to explain all the variations in earnings across occupations. Apart from median age and median years of schooling, other factors which we could expect to explain the variance in earnings not accounted for by our four occupation attributes are, for example, returns to unionism or supply restrictions of various types.

Consider the following regression equation involving 460 U.S. 1970 Census occupations:

$$X_1 = \underset{(460.77)}{5746.90} + \underset{(63.23)}{717.35}Z_{13} + \underset{(57.55)}{704.25}Z_{14} + \underset{(41.46)}{77.21}Z_{15} - \underset{(126.32)}{600.99}Z_1$$

$$\bar{R}^2 = .6853; \quad \bar{S} = \$2112.6 \qquad (3.1)$$

[1]The allocating equations in this section and in section D take advantage of data improvements in the Dictionary of Occupational Titles (DOT), Fourth Edition, 1977. The relevant improvements in the DOT, Fourth Edition are discussed in Appendix A of this dissertation.

where the figures in parentheses are standard errors of the estimated coefficients, and $\tilde{S}$ is the standard error of estimate.

Equation (3.1) implies that increments of gross motor activity (Z_1) have negative value and that the coefficient of Z_{15} (complexity of relations to things) is of doubtful significance. On the other hand, increments of Z_{13} (complexity of relations to data) and Z_{14} (complexity of relations to people) have highly significant positive values.

Due to the facts that Z_1 turned up with the wrong sign and Z_{15} was of doubtful significance, we decided to impose coefficients of \$400 on Z_1 and \$300 on Z_{15}. The justification for imposing \$400 on Z_1 rests on our judgment that employers of labor in the U.S. as of 1969 were unlikely to pay more than \$2,000 for sheer muscular effort. Since Z_1 has five "steps" as defined on the basis of energy consumption, a "step" commands an amount of \$400 given this assumption. The coefficient of \$300 imposed on Z_{15} is based on a regression coefficient of \$334 obtained in a regression of earnings on Z_{15} in 198 blue collar occupations where the complexity of worker function in relation to things is of primary importance in wage determination.[1]

One reason why the negative coefficient of the variable Z_1 in Equation (3.1) seemed implausible, and certainly unsuited to our objectives, was as follows. The attributes of jobs may be viewed as attributes of the programs of the corresponding behavior settings. Since these

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[1]See Appendix B for a detailed discussion of the empirical support for the \$300 coefficient imposed on Z_{15}.

programs impose demands for specified behavior inputs from the workers in each job, the workers, in Barker's terms, must use their various behavior mechanisms at specified tempos and intensities for specified proportions of their occupancy times in the work-setting. Although Barker did not concern himself with wages and salaries, retail sales, household expenditures, or any other financial magnitudes in his behavior setting surveys, the zone 6 leader of a private enterprise setting must employ workers who can supply the behavior inputs required by its program, and he must compete for these workers by offering them financial and nonfinancial inducements or rewards. Therefore, it could not be conceived that an increase in the amount of a behavior input required by a work setting would be associated with a decrease in earnings.

Having imposed coefficients on Z_1 (gross motor activity) and Z_{15} (complexity of relations to things) on the grounds explained above, we then created a new variable $W_1 = X_1 - 400Z_1 - 300Z_{15}$ and used this new variable which "corrects" earnings for the effects of Z_1 and Z_{15} in a regression involving Z_{13} (complexity in relation to data) and Z_{14} (complexity in relation to people). The result obtained in that regression was as follows:

$$W_1 = \$1566.10 + 832.93Z_{13} + 908.80Z_{14}$$
$$(308.27) \quad (74.60) \qquad (69.69)$$
$$\bar{R}^2 = .5499; \quad \bar{S} = \$2782.6 \qquad (3.2)$$

Equation (3.2) states that if we correct earnings for the effects of gross motor activity (Z_1) and relation to things (Z_{15}), we can associate, on the average, a unit increment in Z_{13} (complexity of relations to data) with an increase of about \$833 and a unit increment of Z_{14} (complexity of relations to people) with an increase of about \$909. The mean of W_1 is \$7765.69 and its standard deviation is \$4147.58. The mean of Z_{13} is 4.17 and its standard deviation is 1.98 while the mean of Z_{14} is 3.0 and its standard deviation is 2.12.

From Equation 3.9 we obtained the following estimated equation for the earnings of male workers (X_1):

$$\hat{X}_1 = \$1566.10 + 832.93Z_{13} + 908.80Z_{14} + 300Z_{15} + 400Z_1 \qquad (3.3)$$

We then used Equation 3.3 to obtain residuals, V_1, where $V_1 = (X_1 - \hat{X}_1)$.

When median years of schooling of male workers (X_5) and median age of male workers (X_7) were used as the dependent variables in regressions on the job-descriptive variables Z_{13}, Z_{14}, Z_{15}, and Z_1, the equations obtained were as follows (figures in parentheses are standard errors):

$$\begin{aligned} X_5 = {} & \underset{(0.37)}{10.54} + \underset{(0.05)}{0.45Z_{13}} + \underset{(0.05)}{0.46Z_{14}} - \underset{(0.03)}{0.05Z_{15}} - \underset{(0.10)}{0.32Z_1} \qquad (3.4) \\ & \bar{R}^2 = .5399; \quad \bar{S} = 1.6882 \text{ years} \end{aligned}$$

$$\begin{aligned} X_7 = {} & \underset{(1.53)}{35.45} + \underset{(0.21)}{0.61Z_{13}} + \underset{(0.19)}{0.33Z_{14}} + \underset{(0.14)}{0.21Z_{15}} - \underset{(0.42)}{0.10Z_1} \qquad (3.5) \\ & \bar{R}^2 = .0488; \quad \bar{S} = 6.9996 \text{ years.} \end{aligned}$$

Equation 3.4 implies that a unit increment in the complexity of relations to data (Z_{13}) is associated, on the average, with an increase of 0.45 years of schooling of male workers and a unit increment in the complexity of relations to people (Z_{14}) is associated with an increase of 0.46 years of schooling. The coefficient on Z_{15} (complexity of relations to things) is not significant while the coefficient on Z_1 (heaviness of work) implies that, on the average, a unit increment in the heaviness of work is associated with a decrease of 0.32 years of schooling. On the average, male workers with fewer years of schooling evidently accept jobs involving heavier physical work. Similar interpretations could be made of Equation 3.5.

In our data set of 460 observations, median ages are highest in career occupations requiring long training times and/or long experience--most notably in the professions and in administrative and managerial functions. Within the blue collar occupations, median ages are higher among craftsmen and mechanics than among unskilled laborers and semi-skilled operatives. Hence, median age (a proxy for years of work experience?) is positively associated with earnings, X_1. The positive association of earnings with years of schooling is well-established. For example, our data on earnings, schooling, and age yield the following equation:

$$X_1 = -12.163 + 1142.10X_5 + 181.61X_7 \qquad (3.6)$$
$$(834.15) \quad (43.02) \quad (14.82)$$
$$\bar{R}^2 = 0.67342$$

Equation 3.6 implies an increase of \$1142 in mean annual earnings per year of schooling and an increase of \$182 per year of age.

Our purpose in fitting Equations 3.4 and 3.5 was to use them in obtaining the residuals $V_5 = (X_5 - \hat{X}_5)$ and $V_7 = (X_7 - \hat{X}_7)$ where $\hat{X}_5$ was estimated from Equation 3.4 and $\hat{X}_7$ was estimated from Equation 3.5. V_5 and V_7 are those parts of median years of schooling and median age of male workers that are not correlated with the complexity of worker functions in relation to data, people, things and with the heaviness of work (Z_{13}, Z_{14}, Z_{15}, and Z_1). The residuals V_1 obtained from Equation 3.3, which are interpreted as that part of average yearly earnings (X_1) not correlated with Z_{13}, Z_{14}, Z_{15}, and Z_1, were then regressed on V_5 and V_7, thus obtaining the equation:

$$V_1 = \underset{(61.91)}{844.94V_5} + \underset{(14.93)}{143.47V_7}$$

$$\bar{R}^2 = .3172; \quad \bar{S} = \$2103.3 \qquad (3.7)$$

Our basic allocating equation uses Equations 3.3 and 3.7, and is of the form:

$$\hat{X}_1^* = \$1566.10 + 832.93Z_{13} + 908.80Z_{14} + 300Z_{15} + 400Z_1 + 844.94V_5 + 143.47V_7 \qquad (3.8)$$

Our next step is to allocate the intercept term (\$1566.10) between Z_{13} and Z_{14} in proportion to their regression coefficients. Thus, \$1566.10 [832.93/(832.93 + 908.80)] = \$748.94 is allocated to Z_{13} and \$1566.10 [908.80/(832.93 + 908.80)] - \$817.16 is allocated to Z_{14}. Each of these dollar amounts is equivalent to the effect on earnings (X_1) of an increment of 0.8992 units in the corresponding job-complexity variable.

We then created two new variables:

$Z^*_{13} = Z_{13} + 0.8992,$

$Z^*_{14} = Z_{14} + 0.8992,$

and reduced Equation 3.8 to the form:

$$\hat{X}^*_1 = 832.93Z^*_{13} + 908.80Z^*_{14} + 300Z_{15} + 400Z_1 + 844.95V_5 + 143.47V_7 \tag{3.9}$$

In dollars, the demands on cognitive, affective, psychomotor, and gross motor behavior inputs were estimated from Equation 3.9 as:

$$\hat{z}_{cog} = 832.93Z^*_{13} + 844.95V_5 + 143.47V_7$$

$$\hat{z}_{aff} = 908.80Z^*_{14}$$

$$\hat{z}_{psm} = 300Z_{15}$$

and

$$\hat{z}_{gm} = 400Z_1 \tag{3.10}$$

The proportions of earnings attributed to each of these four behavior inputs were calculated using $\hat{X}^*_1$ in Equation 3.9 as:

$$\lambda_{cog} = \hat{z}_{cog}/\hat{X}^*_1$$

$$\lambda_{aff} = \hat{z}_{aff}/\hat{X}^*_1$$

$$\lambda_{psm} = \hat{z}_{psm}/\hat{X}^*_1$$

$$\lambda_{gm} = \hat{z}_{gm}/\hat{X}^*_1 \tag{3.11}$$

For each of our 460 Census occupations, we calculated $\hat{X}^*_1$ from Equation 3.9 and $\hat{z}_{cog}$, $\hat{z}_{aff}$, $\hat{z}_{psm}$, and $\hat{z}_{gm}$ from 3.10; hence we obtained the proportions in 3.11. The set of proportions in 3.11 varied from occupation to occupation; and in all cases these proportions were applied to actual earnings, X_1, breaking it into the four additive components, z_{cog}, z_{aff}, z_{psm}, and z_{gm}. Actual earnings in all occupations obeyed the accounting rule:

$$X_1 = z_{cog} + z_{aff} + z_{psm} + z_{gm} \quad (3.12)$$

D. Allocating Equations for Assigning Dollar Values to the Behavior Inputs of Female Workers

The DOT-HAJ system does not discriminate between male and female workers. Therefore, the variables Z_{13}, Z_{14}, Z_{15}, and Z_1 also apply to females. But the Census data indicate that females in 1969 worked fewer hours than males and earned considerably less per hour and per year. The census variables X_2, V_6, and V_8 are the female counterparts of X_1, V_5, and V_7.

Our basic allocating equation for females is:

$$\hat{X}_2 = 1591.2 + 533Z_{13} + 397Z_{14} + 180Z_{15} + 240Z_1 + 629V_6 + 55V_8 \quad (3.13)$$

As with males, the coefficients for Z_{15} and Z_1 were imposed due to the reasons explained previously. However, since the mean yearly earnings for females in 1969 were about 60 percent of the mean yearly earnings for males, we are using coefficients on Z_{15} and Z_1 which are 60 percent of the coefficients used on these variables in the allocating equation for males.

The equation fitted for the variable $W_2 = X_2 - 180Z_{15} - 240Z_1$ for females was:

$$W_2 = 1591.20 + 533.38Z_{13} + 396.70Z_{14}$$
$$(203.67) \quad (49.29) \quad (46.05) \tag{3.14}$$
$$\bar{R}^2 = .4408; \quad \bar{S} = \$1838.4$$

and the equation fitted for V_2 was:

$$V_2 = 629.33V_6 + 55.42V_8$$
$$(52.99) \quad (12.57) \tag{3.15}$$
$$\bar{R}^2 = .2338; \quad \bar{S} = 1605.7$$

where V_2 denotes residuals $(X_2-\hat{X}_2)$ and $\hat{X}_2$ was estimated from the equation:

$$\hat{X}_2 = 1591.2 + 533Z_{13} + 397Z_{14} + 180Z_{15} + 240Z_1 \tag{3.16}$$

V_6 denotes residuals from the linear regression of the median years of schooling of females (X_6) on Z_{13}, Z_{14}, Z_{15}, and Z_1; and V_8 denotes residuals from the linear regression of the median age of females (X_8) on Z_{13}, Z_{14}, Z_{15}, and Z_1. The respective equations from which V_6, and V_8 were calculated were:

$$X_6 = 10.54 + 0.326Z_{13} + 0.472Z_{14} - 0.028Z_{15} - 0.235Z_1$$
$$(0.35) \quad (0.048) \quad (0.043) \quad (0.031) \quad (0.095)$$
$$\bar{R}^2 = .4901; \quad \bar{S} = 1.5897 \text{ years.} \tag{3.17}$$

$$X_8 = 38.30 + 0.29Z_{13} + 0.14Z_{14} - 0.19Z_{15} + 0.43Z_1$$
$$(1.46) \quad (0.20) \quad (0.18) \quad (0.13) \quad (0.40)$$
$$\bar{R}^2 = .0065; \quad \bar{S} = 6.7005 \text{ years.} \tag{3.18}$$

Our basic allocating Equation 3.13 uses Equations 3.14 and 3.15. As for males, we allocated the intercept term \$1591.2 between Z_{13} and

Z_{14} in proportion to their statistically estimated regression coefficients and defined two new variables:

$$Z^*_{13(f)} = Z_{13} + 1.71;$$

$$Z^*_{14(f)} = Z_{14} + 1.71.$$

At this stage, Equation (3.14) reduced to:

$$\hat{W}_2 = 533Z^*_{13(f)} + 397Z^*_{14(f)} \qquad (3.19)$$

Hence, Equation 3.13 also reduced to:

$$\hat{X}^*_2 = 533Z^*_{13(f)} + 397Z^*_{14(f)} + 180Z_{15} + 240Z_1 + 629V_6 + 55V_8 \qquad (3.20)$$

Using Equation (3.20), the dollar values allocated to cognitive, affective, psychomotor, and gross motor behavior were estimated as:

$$\hat{z}_{cog} = 533Z^*_{13(f)} + 629V_6 + 55V_8 \qquad (3.20)$$

$$\hat{z}_{aff} = 397Z^*_{14(f)}$$

$$\hat{z}_{psm} = 180Z_{15}$$

$$\hat{z}_{gm} = 240Z_1 \qquad (3.21)$$

The proportions of actual earnings allocated to the four behavior inputs of female workers were then calculated as:

$$\lambda_{cog} = \hat{z}_{cog}/\hat{X}^*_2$$

$$\lambda_{aff} = \hat{z}_{aff}/\hat{X}^*_2$$

$$\lambda_{psm} = \hat{z}_{aff}/\hat{X}^*_2$$

$$\lambda_{gm} = \hat{z}_{gm}/\hat{X}^*_2 \qquad (3.22)$$

Again, for each of the 460 census occupations we applied these proportions to actual earnings of females, X_2, and broke actual earnings into the four additive components z_{psm}, z_{aff}, z_{gm}, and z_{cog}. In general, both the dollar values and the proportions attributed to these components differed somewhat between males and females in the same census occupation and also differed between females in different occupations.

IV. RESULTS AND DISCUSSION

Recall that one of the questions engaged in this dissertation is: How can Barker's data be linked to official data systems? We have argued that four DOT variables, which we have labeled Y_{13}, Y_{14}, Y_{15}, and Y_1, are reasonable proxies for four of Barker's behavior mechanisms, respectively thinking (cognitive behavior), affective behavior, manipulation (psychomotor behavior), and gross motor activity. We have given our reasons for assuming that all behavior inputs can be classified into four categories, cognitive, affective, psychomotor, and gross motor, represented by Barker's four behavior mechanisms and proxied by the four DOT variables just mentioned.

The values of Y_{13}, Y_{14}, Y_{15}, and Y_1 assigned by the DOT to a given occupation can be viewed as a vector of behavior inputs required of members of that occupation by the programs of the work-settings in which that occupation is pursued. The DOT also assigns to each occupation values of attributes which workers must have to meet the demands of their jobs; among these we have used the variables which we have labeled Y_4, Y_5, $Y_{50} = Y_4 + Y_5$, and Y_9. Y_4 is based on the DOT ratings of general educational development (which we have approximated by estimates of the number of years of schooling normally associated with its six DOT levels). Y_5 is based on the DOT ratings of specific vocational preparation time expressed as class intervals of months and years; we have taken the midpoints of these intervals and expressed them in years. Hence, $Y_{50} = Y_4 + Y_5$, which we call training time, is also expressed in years (of general education plus specific vocational preparation). Y_9, which we call cognitive aptitude, is the simple average of DOT ratings on three highly intercorrelated variables, intelligence or general aptitude (G), verbal aptitude (V), and numerical aptitude (N).

These eight DOT-based variables appear to have considerable value for describing occupations and their members, quite apart from analytical and accounting uses. Two more DOT variables, indoor versus outdoor work (which we label Y_2) and absence versus presence of hazardous and/or unpleasant working conditions (which we label Y_3), also have descriptive value. Many other worker attributes (temperaments, interests, finger dexterity, color perception, and so on) are rated in the DOT, but we did not believe that their effects would show up in regression analyses containing the DOT variables already listed.

Certain Census variables relating to occupations also have descriptive value. For male workers, these include variables we have labeled X_1 (mean yearly earnings), X_5 (median years of schooling), X_7 (median age), X_{15} (hours worked per 50 week year), X_{17} (mean hourly earnings), X_{23} (percent of workers with four years of college or more), and X_{25} (percent of workers with less than four years of high school). The corresponding Census variables for female workers we have labeled X_2, X_6, X_8, X_{16}, X_{18}, X_{24}, and X_{26}.

At the U.S. level we have created a data set containing these variables for each of an exhaustive set of 460 civilian occupations.

For tabular presentation, we have combined the 460 into 13 major occupational categories for male and 11 for female workers in Tables 3 and 4. The value of (say) Y_{13} in Table 3 for any given category is the weighted average of Y_{13} over all detailed occupations in it, the weights being their respective proportions of U.S. civilian employment of male workers. In Table 4, the weights are the corresponding proportions of U.S. civilian employment of female workers. Thus, if the 13 values of Y_{13} in the upper portion of Table 3 are weighted by the corresponding 13 values of N_1 (numbers of male workers), they yield a weighted average, $Y_{13} = 3.27$, identical with the weighted average of the 460 detailed occupations. This weighted average applies to the 49,518,000 male workers in the experienced civilian labor force as of 1970. The corresponding weighted average in Table 4, $Y_{13} = 3.75$, applies to the 30,450,000 female workers in the experienced civilian labor force in that year.

The weighted averages of Y_{13} imply that the jobs held by female workers averaged about half a step lower in cognitive complexity than the jobs held by males (3.75 versus 3.27, with the lower number signifying greater complexity). Jobs held by females involved, on the average, slightly less complex relations to people ($Y_{14} = 6.38$ versus 6.31), significantly less complex relations to things ($Y_{15} = 4.51$ versus 4.14), and lighter work ($Y_1 = 1.09$ versus 1.66).

The weighted averages of X_1 and X_2, mean yearly earnings of male and female workers respectively, are of particular interest, as they permit us to link our data set with the national income and product

Table 3. Weighted averages of DOT and Census variables for 13 occupational categories and four larger aggregates: males in the experienced civilian labor force, United States, 1970[a]

Occupational category	N_1 Number of male workers (1,000)	X_1 Mean yearly earnings 1969 (dollars)	Y_{13} Worker functions relating to: Data (Hierarchical level)	Y_{14} People	Y_{15} Things	Y_1 Heaviness of work (level)	Y_4 General educational development (years)	Y_5 Specific vocational preparation (years)
1. Teachers, elem. & sec.	744	9,577	2.00	2.00	7.00	1.00	16.0	2.5
2. Professional, technical	6,249	13,481	0.89	4.50	4.30	0.66	16.6	5.2
3. Managers, administrators	5,395	13,689	1.08	4.17	6.96	0.45	15.1	4.9
4. Sales workers	3,364	10,735	3.14	5.60	7.00	0.96	13.5	1.0
5. Clerical	3,737	8,070	3.22	6.96	5.48	1.15	12.9	0.8
6. Craftsmen, construction	2,989	8,547	3.28	7.55	1.33	2.08	13.2	4.9
7. Mechanics, repairmen	2,466	8,073	2.04	7.12	1.03	2.40	13.8	3.9
8. Other craftsmen	5,104	9,134	2.79	7.65	1.12	1.95	13.3	3.5
9. Operatives (incl. transp. equip.)	9,776	7,416	5.15	7.02	3.65	1.99	11.3	0.7
10. Laborers (excl. farm)	3,433	6,074	6.00	7.75	6.18	3.06	10.0	0.2
11. Farmers and farm workers	2,213	5,586	2.85	6.70	1.74	2.92	12.9	1.5
12. Service workers	4,013	6,267	4.92	6.50	4.56	2.18	11.4	0.5
13. Private household workers	38	3,312	3.91	6.70	4.55	1.13	12.1	0.3
TOTAL, all occupations	49,518	9,179	3.27	6.31	4.14	1.66	13.2	2.5
Larger aggregates:								
Upper white collar (2,3)	11,643	13,577	0.98	4.34	5.53	0.57	15.9	5.1
Lower white collar (1,4,5)	7,844	9,356	3.09	5.90	6.28	1.06	13.5	1.0
Upper blue collar (6,7,8)	10,558	8,720	2.75	7.50	1.16	2.09	13.4	4.0
Lower blue collar (9 through 13)	19,473	6,727	4.99	7.00	4.07	2.32	11.3	0.6
TOTAL, all occupations	49,518	9,179	3.27	6.31	4.14	1.66	13.2	2.5

[a] Source: The Y variables were compiled from the *Dictionary of Occupational Titles* (1965) and its Supplement (1966). The X variables were compiled from the U.S. Census of Population, 1970.

Y_{50}	Y_9	X_5	X_7	X_{15}	X_{17}	Y_2	Y_3	X_{23}	X_{25}
Training time ($Y_4 + Y_5$) (years)	Cognitive aptitude (level)	Median years of schooling	Median age	Hours worked per year (50 weeks)	Mean hourly earnings (dollars)	Indoor versus outdoor work (points)	Work environment (hazardous or unpleasant?)	Percent with 4 years college or more	Percent with less than 4 years high school
18.5	1.73	17.7	33.2	2040	4.69	0.00	0.00	92.6	1.0
21.8	1.75	15.8	38.3	2128	6.30	0.11	0.09	53.8	6.7
20.1	2.01	13.4	44.5	2374	5.84	0.07	0.02	25.0	22.2
14.5	2.89	12.9	39.8	2152	4.96	0.08	0.02	17.2	25.8
13.7	2.85	12.6	37.0	1977	4.08	0.13	0.00	9.1	28.1
18.1	3.28	11.0	42.2	1979	4.32	0.62	0.98	1.0	57.3
17.7	3.11	11.7	39.4	2184	3.71	0.12	0.63	1.1	50.1
16.8	3.17	11.8	41.9	2127	4.29	0.34	0.72	3.2	45.1
12.0	3.72	11.0	37.5	2083	3.56	0.20	0.70	1.0	59.3
10.2	4.06	10.3	33.8	1828	3.33	0.66	0.55	1.1	66.6
14.4	3.45	10.0	45.0	2423	2.27	0.99	0.96	3.0	64.3
11.9	3.62	10.9	39.9	1937	3.21	0.29	0.40	2.4	57.2
12.3	3.68	9.2	45.0	1601	2.04	0.01	0.13	1.7	76.7
15.6	3.02	12.2	39.5	2105	4.33	0.27	0.43	13.8	41.7
21.01	1.87	14.67	41.17	2242	6.09	0.09	0.06	40.44	13.91
14.51	2.76	13.20	37.85	2058	4.51	0.10	0.01	20.47	24.54
17.37	3.19	11.55	41.39	2098	4.16	0.37	0.77	2.11	39.71
11.92	3.73	10.77	38.22	2046	3.30	0.39	0.64	1.54	60.77
15.63	3.02	12.24	39.53	2105	4.33	0.27	0.43	13.8	41.7

Table 4. Weighted averages of DOT and Census variables for 11 occupational categories and four larger aggregates: females in the experienced civilian labor force, United States, 1970[a]

Occupational category	N_2 Number of female workers (1,000)	X_2 Mean yearly earnings 1969 (dollars)	Y_{13} Worker functions relating to: Data (Hierarchical level)	Y_{14} People	Y_{15} Things	Y_1 Heaviness of work (level)	Y_4 General educational development (years)	Y_5 Specific vocational preparation (years)
1. Teachers, elem. & sec.	1,708	7,172	2.00	2.00	7.00	1.00	16.0	1.9
2. Professional, technical	2,967	6,851	1.72	4.96	5.10	1.08	15.4	4.0
3. Managers, administrators	1,084	6,801	1.03	4.53	6.98	0.44	15.1	4.4
4. Sales workers	2,249	3,864	3.73	6.49	6.95	1.03	12.4	0.4
5. Secretaries, stenos, typists	3,792	5,343	3.51	6.51	2.00	0.00	13.4	1.1
6. Other clerical	6,723	4,873	3.55	6.94	4.15	0.57	13.0	0.6
7. Operatives (incl. transp. equip.)	4,570	4,362	5.75	7.38	3.79	1.66	10.9	0.5
8. Other blue collar	855	5,046	4.00	7.62	3.15	2.20	12.2	2.5
9. Farmers and farm workers	254	2,793	4.53	7.39	2.41	2.96	11.9	0.9
10. Service workers	5,061	3,468	4.61	6.98	4.97	1.99	11.8	0.7
11. Private household workers	1,186	1,659	4.11	6.69	4.81	1.20	12.1	0.2
TOTAL, all occupations	30,450	4,799	3.75	6.38	4.51	1.09	12.9	1.2
Larger aggregates:								
Upper white collar (1,2,3)	5,758	6,937	1.67	4.00	6.02	0.93	15.5	3.5
Lower white collar (4,5,6)	12,765	4,835	3.57	6.73	4.00	0.48	13.0	0.7
Upper blue collar (8)	855	5,046	4.00	7.62	3.15	2.20	12.2	2.5
Lower blue collar (7,9,10, 11)	11,071	3,628	5.03	7.12	4.41	1.79	11.4	0.6
TOTAL, all occupations	30,450	4,799	3.75	6.38	4.51	1.09	12.9	1.2

[a]Source: The Y variables were compiled from the Dictionary of Occupational Titles (1965) and its Supplement (1966). The X variables were compiled from the U.S. Census of Population, 1970.

Y_{50} Training time (Y_4 + Y_5) (years)	Y_9 Cognitive aptitude (level)	X_6 Median years of schooling	X_8 Median age	X_{16} Hours worked per year (50 weeks)	X_{18} Mean hourly earnings (dollars)	Y_2 Indoor versus outdoor work (points)	Y_3 Work environment (hazardous or unpleasant?)	X_{24} Percent with 4 years college or more	X_{26} Percent with less than 4 years high school
17.9	2.11	16.7	37.2	1785	4.02	0.00	0.00	85.9	1.4
19.4	2.08	14.5	37.9	1739	3.96	0.19	0.07	34.4	9.7
19.5	2.01	12.8	47.0	2084	3.31	0.01	0.04	14.1	25.9
12.8	3.11	12.2	42.3	1534	2.51	0.09	0.00	3.4	39.3
14.6	2.61	12.6	32.7	1786	2.99	0.00	0.00	4.2	9.6
13.6	2.85	12.4	36.1	1747	2.78	0.02	0.00	3.5	23.6
11.4	3.78	10.7	41.2	1839	2.37	0.01	0.42	0.5	64.3
14.6	3.53	11.4	40.7	1856	2.70	0.38	0.55	1.9	53.5
12.8	3.77	10.2	42.1	1866	1.52	1.00	0.98	2.0	66.3
12.5	3.62	11.3	38.8	1650	2.11	0.05	0.51	1.2	54.8
12.5	3.98	9.1	46.9	1452	1.15	0.00	0.20	0.8	78.3
14.1	3.02	12.3	38.6	1740	2.74	0.06	0.19	10.6	35.1
18.9	2.07	14.80	39.43	1818	3.85	0.10	0.04	45.86	10.26
13.8	2.83	12.46	36.17	1721	2.80	0.03	0.00	3.68	22.22
14.6	3.53	11.42	40.72	1856	2.70	0.38	0.55	1.90	53.47
12.0	3.70	10.77	40.75	1712	2.10	0.05	0.45	0.89	61.54
14.1	3.02	12.26	38.58	1740	2.74	0.06	0.19	10.6	35.1

accounts (apart from small, explicable differences). Multiplying $\overline{X}_1$ = \$9,179 by 49,518,000, the number of male workers, we obtain \$454.5 billion as the estimated earnings of all male workers. The estimated earnings of female workers ($\overline{X}_2$ = \$4,799, multiplied by 30,450,000) come to \$146.1 billion, and total earnings of both sexes are estimated at \$600.7 billion. This differs only slightly, and explicably, from the estimated 1969 earnings of \$576.9 billion reported in the national income accounts.

Moreover, we can use the procedures described toward the end of Chapter III to allocate the earnings (N_1X_1 or N_2X_2) in any occupation among the four categories of behavior inputs. These procedures are of course, tentative and must remain so pending further research and data development. The results of these allocation procedures are shown in Tables 5 and 6.

We also want to demonstrate that our DOT and Census variables may be useful for describing attributes of jobs and workers at the level of counties and groups of counties. At the county level, published employment data are available for the 13 and 11 major occupational categories used in Tables 3 and 4. If we assume that the U.S. average values of DOT and Census variables shown for a given occupational category are fixed attributes of that category in any and every county, the average values of the DOT and Census variables over all occupations will differ from county to county only as a result of differences in occupational mix (i.e., differences in the percentage distributions of male workers among their 13 categories and of female

Table 5. Tentative ascriptions of 1969 total earnings to four kinds of behavior inputs: males in the experienced civilian labor force, United States, 1970[a]

Occupational category	N_1 Number of male workers (1,000)	X_1 Mean yearly earnings (dollars)	N_1X_1 Total earnings (million dollars)
1. Teachers, elem. and sec.	744	9,577	7,121.3
2. Professional, technical	6,249	13,481	84,237.9
3. Managers, administrators	5,395	13,689	73,846.3
4. Sales workers	3,364	10,735	36,108.5
5. Clerical	3,737	8,070	30,157.6
6. Craftsmen, construction	2,989	8,547	25,544.5
7. Mechanics, repairmen	2,466	8,073	19,906.8
8. Other craftsmen	5,104	9,134	46,618.8
9. Operatives (incl. transp. equip.)	9,776	7,416	72,493.3
10. Laborers (excl. farm)	3,433	6,074	20,853.9
11. Farmers and farm workers	2,213	5,586	12,362.8
12. Service workers	4,013	6,267	25,149.8
13. Private household workers	38	3,312	125.3
TOTAL, all occupations	49,518	9,179	454,526.8
Larger aggregates:			
Upper white collar (2,3)	11,644	13,576	158,084
Lower white collar (1,4,5)	7,845	9,355	73,388
Upper blue collar (6,7,8)	10,559	8,720	92,071
Lower blue collar (9,10,11, 12,13)	19,470	6,726	130,984
TOTAL, all occupations	49,518	9,179	454,527

[a]These computations have been made on the basis of the figures in the U.S. Census of Population, 1970.

$N_1X_{1 \cdot cog}$	$N_1X_{1 \cdot aff}$	$N_1X_{1 \cdot psm}$	
Earnings ascribed to inputs of:			
Cognitive behavior (million dollars)	Affective behavior (million dollars)	Psychomotor behavior (million dollars)	Gross motor activity (million dollars)
2,913.2	3,652.1	152.6	407.0
41,090.9	31,714.3	7,180.1	4,257.4
33,132.3	34,696.9	2,104.1	3,918.4
15,778.8	15,939.0	1,223.5	3,172.6
14,130.7	10,079.1	2,807.6	3,140.9
10,500.1	5,995.9	5,573.0	3,478.6
8,399.9	4,823.5	4,050.2	2,634.9
21,845.1	9,557.8	9,684.3	5,532.2
21,688.1	26,097.0	12,787.0	11,922.8
4,935.3	7,576.6	2,018.3	6,323.6
4,085.4	3,716.3	2,459.3	2,099.9
7,432.9	10,280.5	3,241.7	4,195.6
30.5	58.1	20.0	17.3
185,963.2	164,187.1	53,301.6	51,101.2
74,233.2	66,411.2	9,284.2	8,175.8
32,822.8	29,670.2	4,183.7	6,720.5
40,745.1	20,377.2	19,307.5	11,645.7
38,172.1	47,728.6	20,526.3	24,559.2
185,963.2	164,187.1	53,301.6	51,101.3

Table 6. Tentative ascriptions of 1969 total earnings to four kinds of behavior inputs: females in the experienced civilian labor force, United States, 1970[a]

	N_2	X_2	N_2X_2
Occupational category	Number of female workers (1,000)	Mean yearly earnings (dollars)	Total earnings (million dollars)
1. Teachers, elem. and sec.	1,708	7,172	12,245.9
2. Professional, technical	2,967	6,851	20,327.9
3. Managers, administrators	1,084	6,801	7,369.8
4. Sales workers	2,249	3,864	8,692.1
5. Secretaries, stenos, typists	3,792	5,343	20,260.5
6. Other clerical	6,723	4,873	32,763.7
7. Operatives (incl. transp. equip.)	4,570	4,362	19,932.0
8. Other blue collar	855	5,046	4,316.7
9. Farmers and farm workers	254	2,793	708.1
10. Service workers	5,061	3,468	17,552.7
11. Private household workers	1,186	1,659	1,968.8
TOTAL, all occupations	30,450	4,799	146,138.2
Larger aggregates:			
Upper white collar (1,2,3)	5,759	6,936	39,944
Lower white collar (4,5,6)	12,764	4,835	61,717
Upper blue collar (8)	855	5,046	4,317
Lower blue collar (7,9, 10,11)	11,072	3,627	40,160
TOTAL, all occupations	30,450	4,799	146,138

[a]These computations have been made on the basis of the figures in the U.S. Census of Poulation, 1970.

$N_2X_{2 \cdot cog}$	$N_2X_{2.aff}$	$N_2X_{2 \cdot psm}$	$N_2X_{2 \cdot gm}$
Earnings ascribed to inputs of:			
Cognitive behavior (million dollars)	Affective behavior (million dollars)	Psychomotor behavior (million dollars)	Gross motor activity (million dollars)
6,334.6	4,965.8	258.6	689.7
11,317.6	6,218.8	1,429.8	1,360.4
3,981.0	2,791.8	208.3	391.4
4,647.3	2,905.7	319.8	818.2
9,350.7	6,064.5	3,964.5	880.9
16,940.6	9,287.8	4,160.9	2,372.5
7,049.7	6,281.9	3,541.8	3,059.2
2,055.8	969.5	668.4	620.8
217.1	195.1	151.1	146.1
7,395.1	5,565.1	1,884.7	2,706.6
534.1	841.5	311.0	281.7
69,823.6	46,087.6	16,898.8	13,327.5
21,633.2	13,976.5	1,896.7	2,441.5
30,938.6	18,258.1	8,445.2	4,071.6
2,055.8	969.5	668.4	620.8
15,197.0	12,883.6	5,888.5	6,193.6
69,823.6	46,087.6	16,898.8	13,327.5

workers among their 11 categories).

To gain some insight into the descriptive usefulness of this approach, we present a number of tables for the Des Moines BEA Economic Area and its subareas and for the Des Moines FEA and its counties. Estimates of total earnings and their tentative allocations among four categories of behavior inputs are also presented for the Des Moines BEA Economic Area and the Des Moines FEA.

A. Preliminary Accounts for the United States

In the introductory part of this chapter, we noted that our N_1X_1 and N_2X_2 combined total \$600.7 billion compared to the \$576.9 billion of earnings reported in the national income accounts. The discrepancy of approximately four percent between our figures and those in the national income accounts can be explained by the following facts. Our N_1 and N_2 are 1970 Census figures on members of the experienced civilian labor force and so they are a little higher than the time series figures on civilian employment. Our X_1 and X_2 assume that everybody in the experienced civilian labor force is employed 50 to 52 weeks whereas in actuality some of those included in our N_1 and N_2 worked fewer weeks than that. So our X_1 and X_2 variables represent the market values of 50 to 52 weeks of labor which are slightly higher than those of the average numbers of weeks actually worked. Finally, there probably would be some discrepancy between Census estimates of 1969 mean yearly earnings (X_1 and X_2) based on questionnaires filled out by individuals and the official national income accounts which use additional and alternative time series data sources, including for example, such things as Social Security Administration quarterly records of actual wages and salaries paid by employers to about 95 percent of all workers.

Tables 3 and 4 display the weighted averages of DOT and Census variables for males and females, respectively, and their four larger aggregates for the United States as of 1970. Tables 5 and 6 display our tentative ascriptions of 1969 total earnings of males and females in that order to four kinds of behavior inputs. In Tables 5 and 6 we have also shown total earnings N_1X_1 and N_2X_2.

If we had annual or quarterly data at the U.S. level on N_1X_1 and N_2X_2 as well as their ascriptions to cognitive, affective, psychomotor, and gross motor inputs, we could build these variables into existing U.S. econometric models and see if they give some new and interesting insights. For example, the declining percentage of total employment of males in primary activities implies that a smaller percentage of N_1X_1 is attributed to gross motor activity. Also, the DOT ratings of Y_1 for farmers should be modified over time if mechanization makes farming <u>lighter</u> work. At the same time, Y_{13} would trend upward for farmers because of increasing complexity of <u>management decisions</u>. Over the past 50 years, the "typical farmer" has changed from mostly laborer to mostly manager and equipment operator.

If, in addition, we had at the U.S. level time series data on all uses of time for various population subgroups by age and sex, etc., we could build U.S. sociometric models which would show, for example, which uses of time are expanded when unemployment increases. One relevant question in this framework is, for example: does unemployment of a husband change only his own time allocation or does it also change the time allocations of (i) his working wife or (ii) his nonworking wife, and (iii) his children?

Perhaps more on a trend than on a cycle basis, sociometric accounts and models of the U.S. would include time spent (and its imputed dollar values) on housework and other nonmarket activities by both wives and husbands, not to mention single persons living alone and children of all ages. The present fragmentary calculations of (1) the economic value of a housewife, (2) the value of "household production," and (3) the value of education would be replaced by analogous and consistent estimates covering all uses of time and broken down into major categories of time use by major population age-and-sex subgroups.

The present situation is that we have internally consistent accounts and models of the economy, gainful employment in which absorbs only 15 percent of the society's total waking hours, plus scattered, ad hoc, unrelated, and almost certainly inconsistent studies for bits and pieces of the other 85 percent. Comprehensive time allocation data would force some consistency into ad hoc estimates of costs and benefits of market and nonmarket programs affecting (primarily) different age and/or sex and/or other population subgroups.

B. Preliminary Accounts for the Des Moines BEA Economic Area and its Subareas

The Des Moines BEA Economic Area is comprised of 26 contiguous counties in the southern part of Iowa. These 26 counties are delineated into four subareas.

Tables 7 and 8 present the occupational distributions of employed workers in the Des Moines BEA Economic Area and its subareas in 1970. From Table 7 we see that farmers and farm workers made up 14.5 percent of male workers in the entire Des Moines BEA area as of 1970. However, this same group represents 39.2 percent of employment in Fiveco, 23.4 percent in the Ottumwa FEA, 23.3 percent in the MTP subarea and 8.2 percent in the Des Moines FEA. In the upper section of Table 7, professional and technical workers account for 10.7 percent of employment in the Des Moines BEA area itself but the same group represents 5.6 percent of the employment in Fiveco, 6.0 percent in the Ottumwa FEA, 7.8 percent in the MTP subarea, and 12.9 percent in the Des Moines FEA. Managers and administrators also show a good deal of variation ranging from 9.3 percent of employment in Fiveco to 13.4 percent of employment in the Des Moines FEA.

Table 8 decomposes the distribution of employed males in the Des Moines FEA into its eight component counties. In the lower portion of this table, the more striking figures are as follows. In Story County, the county in which Iowa State University is located, the upper white collar (UWC) category constitutes about 39 percent of employment and the lower blue collar (LBC) category about 24 percent. In Polk County, the UWC category makes up about 28 percent of employment while the LBC category accounts for about 32 percent. Farmers and farm workers represent only 1.5 percent of employment in Polk County as compared with 36.9 percent in Madison. Polk County has the highest percentage of lower white collar (LWC) employment at 20.4.

The other five counties in the Des Moines FEA (exclusive of Story, Polk, and Madison) have rather similar occupational distributions, with

Table 7. Percentage distribution of employment among 13 occupational categories and five larger aggregates: 16 years old and over, Des Moines BEA area and its subareas, 1970

Occupational category	Des Moines BEA area 1970	Fiveco subarea, 1970	Ottumwa FEA 1970	MTP subarea, 1970	Des Moines FEA 1970
	Percentage distribution of employment: males				
1. Teachers, elem. and sec.	1.51	1.50	1.35	1.69	1.52
2. Professional, technical	10.65	5.62	6.02	7.82	12.92
3. Managers, administrators	12.35	9.28	10.89	10.09	13.42
4. Sales workers	6.80	4.46	5.60	5.31	7.62
5. Clerical	6.61	3.43	4.40	5.02	7.80
6. Craftsmen, construction	4.87	4.59	4.99	4.69	4.89
7. Mechanics, repairmen	2.34	2.01	2.21	1.89	2.48
8. Other craftsmen	9.68	5.77	8.64	10.23	10.26
9. Operatives (incl. transp. equip.)	17.29	12.95	19.48	19.16	16.76
10. Laborers. (excl. farm)	6.22	5.48	6.82	5.24	6.28
11. Farmers and farm workers	14.48	39.19	23.40	23.30	8.15
12. Service workers	7.14	5.67	6.05	5.54	7.85
13. Private household workers	0.06	0.04	0.15	0.02	0.05
TOTAL, all occupations	100.00	100.00	100.00	100.00	100.00
Larger aggregates:					
Upper white collar (2,3)	23.00	14.90	16.91	17.91	26.34
Lower white collar (1,4,5)	14.92	9.39	11.35	12.02	16.94
Upper blue collar (6,7,8)	16.89	12.37	15.84	16.81	17.63
Lower blue collar (9,10,12,13)	30.71	24.14	32.50	29.96	30.94
Farmers and farm workers (11)	14.48	39.19	23.40	23.30	8.15
TOTAL, all occupations	100.00	100.00	100.00	100.00	100.00

Table 8. Percentage distribution of employment among 13 occupational categories and five larger aggregates, by counties: males 16 years and over, Des Moines FEA, 1970

Occupational category	Des Moines FEA 1970	Boone 1970	Story 1970	Dallas 1970	Polk 1970	Jasper 1970	Madison 1970	Warren 1970	Marion 1970
	Percentage distribution of employment: males								
1. Teachers, elem. & sec.	1.52	1.34	1.70	2.04	1.36	1.96	1.02	1.68	2.04
2. Professional, technical	12.92	8.21	28.58	4.79	12.48	7.92	3.51	8.17	8.54
3. Managers, administrators	13.42	10.24	10.31	11.04	15.70	11.61	9.34	10.66	8.64
4. Sales workers	7.62	6.24	5.40	5.82	9.42	4.22	4.07	5.89	4.49
5. Clerical	7.80	4.79	5.49	5.76	9.58	4.63	4.03	6.79	5.96
6. Craftsmen, construction	4.89	6.63	4.27	6.77	4.61	4.32	5.57	5.20	6.05
7. Mechanics, repairmen	2.48	2.94	2.23	2.81	2.51	2.35	1.90	3.12	1.79
8. Other craftsmen	10.26	9.19	6.50	9.56	11.19	11.05	11.87	11.86	7.27
9. Operatives (incl. transp. equip.)	16.76	17.19	9.41	20.08	16.45	23.03	13.34	21.77	22.20
10. Laborers (excl. farm)	6.28	7.79	4.43	6.18	6.81	5.09	5.41	5.98	6.02
11. Farmers and farm workers	8.15	18.93	11.69	19.37	1.52	18.75	36.92	13.53	17.04
12. Service workers	7.85	6.51	9.96	5.73	8.34	4.93	2.89	5.36	9.89
13. Private household workers	0.05	0.00	0.03	0.07	0.04	0.15	0.13	0.00	0.06
TOTAL, all occupations	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Larger aggregates:									
Upper white collar (2,3)	26.34	18.45	38.89	15.83	28.18	19.53	12.85	18.83	17.18
Lower white collar (1,4,5)	16.94	12.37	12.59	13.62	20.36	10.81	9.12	14.36	12.49
Upper blue collar (6,7,8)	17.63	18.76	13.00	19.14	18.31	17.72	19.34	20.18	15.11
Lower blue collar (9,10,12,13)	30.94	31.49	23.83	32.06	31.64	33.20	21.77	33.11	38.17
Farmers and farm workers (11)	8.15	18.93	11.69	19.37	1.52	18.75	36.92	13.53	17.04
TOTAL, all occupations	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

farmers and farm workers ranging from 13.5 to 18.9 percent; lower blue collar from 31.5 to 38.2 percent; upper blue collar from 15.1 to 20.2 percent; lower white collar from 10.8 to 14.4 percent; and upper white collar from 15.8 to 19.5 percent. Each of the five counties has at least one city of 6,000 population or more but none has a city of more than 16,000. In contrast, Polk and Story Counties have much larger cities, and Madison has no town as large as 4,000.

Tables 9 and 10 present similar information for females. In Table 9, we see that, in the BEA area as a whole, females have their largest percentage of employment in the lower white collar (LWC) category representing 43.1 percent. Lower blue collar (LBC) makes up 32.8 percent of female employment in the Des Moines BEA area. Farmers and farm workers account for only 1.3 percent and upper blue collar (UBC) for only 2.9 percent; upper white collar employment (UWC) is substantial at 19.9 percent.

Among the subareas, the Des Moines FEA has by far the highest percentage of LWC workers at 47.2 and the lowest percentage of LBC workers at 29.1. The other three subareas have from 18.0 to 19.3 percent of UWC workers, 2.8 to 3.4 percent of UBC, and 39.6 to 41.8 percent of LBC, showing little variation in these respects. Fiveco has the highest percentage of farmers and farm workers (7.4) and the lowest percentage of LWC workers (31.3).

In Table 10 we have disaggregated the figures for the Des Moines FEA into its component counties. Story County, the site of Iowa State University, has by far the largest percentage of upper white collar workers at 28.6, and Polk County has the largest percentage of lower white collar workers at 52.1. Warren County has the next largest percentage of LWC

Table 9. Percentage distribution of employment among 11 occupational categories and five larger aggregates: females 16 years and over, Des Moines BEA and its subareas, 1970

Occupational category	Des Moines BEA area 1970	Fiveco subarea 1970	Ottumwa FEA 1970	MTP subarea 1970	Des Moines FEA 1970
	Percentage distribution of employment: females				
1. Teachers, elem. and sec.	6.33	8.05	7.64	6.82	5.82
2. Professional technical	9.51	6.36	7.58	7.55	10.48
3. Managers, administrators	4.02	3.57	4.07	3.79	4.08
4. Sales workers	7.06	5.66	7.17	7.87	7.04
5. Secretaries, stenos, typists	11.63	7.25	7.80	8.06	13.35
6. Other clerical	24.44	18.43	18.61	20.71	26.79
7. Operatives (incl. transp. equip.)	7.69	7.46	11.88	9.37	6.47
8. Other blue collar	2.92	2.76	3.41	3.07	2.79
9. Farmers and farm workers	1.32	7.38	1.92	2.55	0.55
10. Service workers	21.25	27.57	25.46	24.84	19.28
11. Private household workers	3.84	5.50	4.45	5.37	3.36
TOTAL, all occupations	100.00	100.00	100.00	100.00	100.00
Larger aggregates:					
Upper white collar (1,2,3)	19.86	17.98	19.29	18.16	20.38
Lower white collar (4,5,6)	43.13	31.34	33.58	36.64	47.18
Upper blue collar (8)	2.92	2.76	3.41	3.07	2.79
Lower blue collar (7,10,11)	32.78	40.53	41.79	39.58	29.11
Farmers and farm workers (9)	1.32	7.38	1.92	2.55	0.55
TOTAL, all occupations	100.00	100.00	100.00	100.00	100.00

Table 10. Percentage distribution of employment among 11 occupational categories and five larger aggregates, by counties: females 16 years old and over, Des Moines FEA, 1970

Occupational category	Des Moines FEA 1970	Boone 1970	Story 1970	Dallas 1970	Polk 1970	Jasper 1970	Madison 1970	Warren 1970	Marion 1970
	Percentage distribution of employment: females								
1. Teachers, elem & sec.	5.82	5.86	6.32	7.75	5.36	6.23	7.08	6.67	6.69
2. Professional, technical	10.48	6.20	19.43	7.80	10.20	5.43	7.29	8.44	7.20
3. Managers, administrators	4.08	3.96	2.81	3.90	4.37	4.10	4.35	5.20	2.59
4. Sales workers	7.04	7.18	5.20	7.64	7.57	6.21	7.36	4.62	7.53
5. Secretaries, stenos, typists	13.35	7.57	12.95	10.91	15.02	10.60	7.57	11.29	8.15
6. Other clerical	26.79	18.73	21.07	23.69	29.53	22.74	26.30	30.43	18.24
7. Operatives (incl. transp. equip.)	6.47	9.41	5.80	5.67	5.59	12.38	6.03	4.81	11.84
8. Other blue collar	2.79	3.74	1.76	1.42	2.96	3.40	3.37	3.35	2.10
9. Farmers & farm workers	0.55	0.81	0.61	0.95	0.15	1.80	2.31	1.35	1.78
10. Service workers	19.28	31.16	18.72	26.90	16.80	21.76	25.46	19.46	29.08
11. Private household workers	3.36	5.39	5.34	3.37	2.45	5.36	2.88	4.38	4.80
TOTAL, all occupations	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Larger aggregates:									
Upper white collar (1,2,3)	20.38	16.02	28.56	19.45	19.93	15.76	18.72	20.31	16.48
Lower white collar (4,5,6)	47.18	33.48	39.22	42.24	52.12	39.55	41.23	46.34	33.92
Upper blue collar (8)	2.79	3.74	1.76	1.42	2.96	3.40	3.37	3.35	2.10
Lower blue collar (7,10,11)	29.11	45.96	29.86	35.94	24.84	39.50	34.37	28.65	45.72
Farmers & farm workers (9)	0.55	0.81	0.61	0.95	0.15	1.80	2.31	1.35	1.78
TOTAL, all occupations	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

workers (46.3), but many of the jobs involved are located in Polk County (Des Moines); the employment figures in Tables 7 through 10 are by county of <u>residence</u> rather than county of <u>work</u>. Boone and Marion counties are low in LWC employment at 33.5 and 33.9 percent and high in LBC employment at 46.0 and 45.7 percent.

In Table 11 we show the effects of differences in occupational mix upon average values of selected DOT and Census variables in the Des Moines BEA Economic Area and its subareas (males); the variables used here are weighted average values taken over all occupations of selected DOT and Census variables and depict the 1970 situation in the Des Moines BEA Economic Area.

By occupational mix, we mean differences in the proportional distributions of male workers over 13 categories or of female workers over 11 categories.

Tables 11 and 12 show the estimates of the average values of selected DOT and Census variables in the Des Moines BEA Economic Area and its subareas. Table 11 shows that the computed mean yearly earnings in 1969 ranges from a low of $7,849 in the Fiveco subarea to a high of $9,300 in the Des Moines FEA. On the other hand, computed hours worked per 50-week year are lowest in the Des Moines FEA with 2126 hours but highest in the Fiveco subarea with 2222 hours.

The computed percent with four years college (X_{23}) is lowest in the Fiveco subarea at 9.6 percent and highest in the Des Moines FEA at 14.8 percent. Correspondingly, the computed percent with less than four years high school (X_{25}) is 50.6 percent in Fiveco but 40.6 percent in the Des Moines FEA. The Des Moines FEA also has the smallest proportion of

Table 11. Weighted average of DOT and Census variables (all occupations): male workers 16 years old and over, Des Moines BEA area and its subareas, 1970

Variables	Des Moines BEA area 1970	Fiveco subarea 1970	Ottumwa FEA 1970	MTP subarea 1970	Des Moines FEA 1970
	Weighted averages (all occupations): males				
X_1 Mean yearly earnings, 1969	\$8,942	\$7,849	\$8,332	\$8,448	\$9,300
X_5 Median years of schooling	12.04	11.36	11.61	11.73	12.28
X_7 Median age	40.24	41.60	40.67	40.69	39.91
X_{15} Hours worked per year (50 weeks)	2,145	2,222	2,170	2,173	2,126
X_{17} Mean hourly earnings, 1969	\$4.16	\$3.56	\$3.85	\$3.90	\$4.35
X_{23} Percent with 4 years college	13.22	9.57	10.05	11.14	14.81
X_{25} Percent with less than 4 years high school	43.25	50.61	48.09	46.83	40.58
Y_{13} Level of work relating to data	3.19	3.18	3.35	3.26	3.14
Y_{14} Level of work relating to people	6.27	6.42	6.43	6.40	6.19
Y_{15} Level of work relating to things	4.05	3.39	3.75	3.68	4.26
Y_1 Strength required	1.74	2.13	1.94	1.91	1.62
Y_2 Indoor versus outdoor work	0.34	0.52	0.56	0.41	0.29
Y_3 Work environment	0.47	0.63	0.56	0.55	0.41
Y_4 General educational development	13.16	12.99	12.91	13.03	13.28
Y_5 Specific vocational preparation	2.37	2.08	2.14	2.22	2.49
Y_{50} Training time ($Y_4 + Y_5$)	15.55	15.08	15.05	15.26	15.78
Y_9 Cognitive aptitude required	3.04	3.20	3.17	3.13	2.97
N_1 Number of male workers	195,438	11,971	36,418	20,509	126,540

Table 12. Weighted averages of DOT and Census variables (all occupations): male workers 16 years old and over, Des Moines FEA and its counties, 1970

Variables	Des Moines FEA 1970	Boone 1970	Story 1970	Dallas 1970	Polk 1970	Jasper 1970	Madison 1970	Warren 1970	Marion 1970
	Weighted averages (all occupations): males								
X_1 Mean yearly earnings, 1969	$9,300	$8,550	$9,834	$8,426	$9,606	$8,617	$7,891	$8,750	$8,404
X_5 Median years of schooling	12.28	11.77	12.83	11.69	12.43	11.82	11.30	11.92	11.78
X_7 Median age	39.91	40.40	39.96	40.49	39.63	40.45	41.68	40.09	40.09
X_{15} Hours worked per year (50 weeks)	2126	2150	2138	2156	2108	2163	2218	2140	2134
X_{17} Mean hourly earnings, 1969	$4.35	$3.98	$4.59	$3.92	$4.51	$3.99	$3.59	$4.09	$3.94
X_{23} Percent with 4 years college	14.81	11.11	21.97	10.14	15.30	11.52	8.06	11.53	11.31
X_{25} Percent with less than 4 years high school	40.58	46.49	35.42	47.31	38.47	46.19	51.01	44.90	46.83
Y_{13} Level of work relating to data	3.14	3.31	2.69	3.36	3.14	3.29	3.18	3.32	3.46
Y_{14} Level of work relating to people	6.19	6.42	5.85	6.45	6.15	6.37	6.56	6.41	6.40
Y_{15} Level of work relating to things	4.26	3.82	4.17	3.78	4.55	3.75	3.21	3.87	3.86
Y_1 Strength required	1.62	1.89	1.52	1.90	1.50	1.85	2.13	1.80	1.88
Y_2 Indoor versus outdoor work	0.29	0.40	0.29	0.39	0.23	0.37	0.53	0.34	0.37
Y_3 Work environment	0.41	0.53	0.37	0.54	0.36	0.54	0.65	0.50	0.53
Y_4 General educational development	13.28	12.99	13.90	12.91	13.30	13.02	12.96	13.01	12.88
Y_5 Specific vocational preparation	2.49	2.28	2.96	2.19	2.53	2.28	2.17	2.29	2.10
Y_{50} Training time ($Y_4 + Y_5$)	15.78	15.28	16.87	15.12	15.85	15.31	15.14	15.31	14.99
Y_9 Cognitive aptitude required	2.97	3.13	2.76	3.16	2.93	3.12	3.22	3.11	3.16
N_1 Number of male workers	126,540	6,249	16,029	6,769	72,075	9,079	3,050	6,979	6,310

outdoor work (Y_2) at 0.29 and Fiveco has the largest at 0.52. Similarly, the Fiveco subarea has the largest proportion of unpleasant or hazardous work environments (0.63) while the Des Moines FEA has the smallest (0.41).

Table 12 presents similar information for the Des Moines FEA and its component counties. In this table, we find that Story County has the highest computed mean yearly earnings in 1969 ($9,834) while Madison County has the lowest ($7,891). Polk County is closest to Story County in mean yearly earnings in 1969 with $9,606. The computed median age in these three counties is about 39.9 in Story, 41.7 in Madison, and 39.6 in Polk. Computed average hours worked per 50-week year is 2,138 in Story, 2,108 in Polk, and 2,218 in Madison, and computed mean hourly earnings in 1969 are $4.59 in Story, $4.51 in Polk, and $3.59 in Madison. The proportion of outdoor work is about 0.3 in Story County, 0.2 in Polk, and 0.5 in Madison. The proportion of work environments that are hazardous or unpleasant is less than 0.4 in Story and Polk counties and more than 0.6 in Madison. The computed percent of workers with four years college (X_{23}) is about 22 percent in Story County, 15 percent in Polk and 8 percent in Madison. Conversely, the computed percent of workers with less than four years high school (X_{25}) is 35 percent in Story County, 38 percent in Polk, and 51 percent in Madison county. Variations among such measures for the other five counties are relatively small.

The variables in Tables 13 and 14 are the same as in Tables 11 and 12 except that they now relate to females.

Table 13. Weighted averages of DOT and Census variables (all occupations): female workers 16 years old and over, Des Moines BEA area and its subareas, 1970

Variables		Weighted averages (all occupations): females				
		Des Moines BEA area 1970	Fiveco subarea 1970	Ottumwa FEA 1970	MTP subarea 1970	Des Moines FEA 1970
X_2	Mean yearly earnings, 1969	$4,784	$4,479	$4,646	$4,593	$4,866
X_6	Median years of schooling	12.35	12.10	12.20	12.17	12.43
X_8	Median age	38.42	39.09	38.99	38.96	38.15
X_{16}	Hours worked per year (50 weeks)	1,732	1,728	1,730	1,723	1,733
X_{24}	Percent with 4 years college	11.26	11.36	11.47	10.82	11.27
X_{26}	Percent with less than 4 years high school	33.74	39.51	38.04	37.74	31.74
Y_{13}	Level of work relating to data	3.63	3.80	3.79	3.76	3.56
Y_{14}	Level of work relating to people	6.32	6.36	6.33	6.36	6.31
Y_{15}	Level of work relating to things	4.60	4.62	4.71	4.70	4.56
Y_1	Strength required	1.10	1.35	1.25	1.22	1.02
Y_2	Indoor versus outdoor work	0.07	0.12	0.07	0.08	0.06
Y_3	Work environment	0.19	0.28	0.23	0.23	0.16
Y_4	General educational development	13.02	12.82	12.84	12.85	13.10
Y_5	Specific vocational preparation	1.26	1.15	1.20	1.17	1.29
Y_{50}	Training time (Y_4 + Y_5)	14.29	13.98	14.05	14.03	14.40
Y_9	Cognitive aptitude required	2.99	3.12	3.09	3.08	2.94
N_2	Number of female workers	118,442	6,163	19,647	10,904	81,728

Table 14. Weighted averages of DOT and Census variables (all occupations): female workers 16 years old and over, Des Moines FEA and its counties, 1970

	Variables	Des Moines FEA 1970	Boone 1970	Story 1970	Dallas 1970	Polk 1970	Jasper 1970	Madison 1970	Warren 1970	Marion 1970
		Weighted averages (all occupations): females								
X_2	Mean yearly earnings, 1969	$4,866	$4,501	$4,991	$4,722	$4,935	$4,617	$4,702	$4,839	$4,525
X_6	Median years of schooling	12.43	12.06	12.59	12.38	12.48	12.11	12.31	12.39	12.11
X_8	Median age	38.15	39.02	38.20	38.36	37.93	38.80	38.58	38.27	38.89
X_{16}	Hours worked per year (50 weeks)	1,733	1,717	1,725	1,722	1,738	1,734	1,730	1,739	1,718
X_{18}	Mean hourly earnings, 1969	$2.79	$2.60	$2.87	$2.72	$2.82	$2.64	$2.70	$2.76	$2.61
X_{24}	Percent with 4 years college	11.27	9.50	14.31	11.86	10.96	9.72	11.16	11.44	10.35
X_{26}	Percent with less than 4 years high school	31.74	39.56	30.48	33.93	29.99	37.59	35.17	32.22	39.12
Y_{13}	Level of work relating to data	3.56	3.85	3.40	3.64	3.51	3.82	3.66	3.53	3.88
Y_{14}	Level of work relating to people	6.31	6.44	6.13	6.27	6.31	6.43	6.34	6.29	6.41
Y_{15}	Level of work relating to things	4.56	4.73	4.60	4.72	4.51	4.54	4.72	4.57	4.69
Y_1	Strength required	1.02	1.27	1.05	1.12	0.96	1.16	1.18	1.04	1.27
Y_2	Indoor versus outdoor work	0.06	0.06	0.07	0.06	0.05	0.06	0.08	0.06	0.07
Y_3	Work environment	0.16	0.24	0.16	0.19	0.14	0.22	0.21	0.17	0.24
Y_4	General educational development	13.10	12.74	13.32	13.01	13.15	12.79	12.95	13.11	12.74
Y_5	Specific vocational preparation	1.29	1.13	1.53	1.19	1.30	1.12	1.21	1.28	1.10
Y_{50}	Training time ($Y_4 + Y_5$)	14.40	13.87	14.86	14.21	14.46	13.92	14.17	14.41	13.84
Y_9	Cognitive aptitude required	2.94	3.13	2.87	3.00	2.90	3.09	3.03	2.94	3.13
N_2	Number of female workers	81,728	3,582	10,048	3,795	50,233	5,171	1,426	3,766	3,707

Comparing Tables 11 and 13, we see that mean yearly earnings of males (X_1) is 18.5 percent higher in the Des Moines FEA than it is in Fiveco but mean yearly earnings of females (X_2) is only 8.6 percent higher in the Des Moines FEA than in Fiveco. Mean hourly earnings of males (X_{17}) is 22.2 percent higher in the Des Moines FEA than in Fiveco, but mean hourly earnings of females (X_{18}) is still only 8.6 percent higher in the Des Moines FEA than in Fiveco.

Similarly, comparing Tables 12 and 14, we see that the percentage differences for females are also smaller than those for males. For example, the highest county on mean yearly earnings of males (X_1, Table 12) as well as on mean yearly earnings of females (X_2, Table 14) is Story County. For males, the Story County figure is 19.8 percent higher than the figure for the lowest county (Madison). But for females, the Story County figure is only 9.8 percent higher than the figure for the lowest county (Boone). For mean hourly earnings, we find a similar relationship. Story County is the highest county on both the male and female figures. For males, the Story County figure is 21.8 percent higher than the figure for the lowest county (Madison) whereas for females, the Story County figure is only a modest 9.4 percent higher than the figure for the lowest county (Boone).

In Table 13, mean yearly earnings for females in the Des Moines BEA Economic Area range from a low of $4,479 in the Fiveco subarea to a high of $4,866 in the Des Moines FEA. Computed median years of schooling for females is 12.1 years in Fiveco and 12.4 years in the

Des Moines FEA. Computed hours worked per week is 1,728 in Fiveco and 1,733 in the Des Moines FEA; and computed mean hourly earnings are $2.57 in Fiveco and $2.79 in the Des Moines FEA. The computed percent of workers with four years college is about the same in the two subareas, 11.4 percent in Fiveco and 11.3 percent in the Des Moines FEA. However, the computed percent with less than four years high school is 39.5 in Fiveco but only 31.7 in the Des Moines FEA.

The computed proportion of outdoor work is 0.12 in Fiveco and 0.06 in the Des Moines FEA, while the computed proportion of the work environments that is unpleasant or hazardous is 0.28 in Fiveco and 0.16 in the Des Moines FEA.

Computed training time (general educational development plus specific vocational preparation) is about 14.0 years for Fiveco and 14.4 years for the Des Moines FEA. Des Moines FEA female workers also face jobs that are somewhat more demanding in relation to "data" and "people" with values of Y_{13} and Y_{14} at 3.56 and 6.31, respectively, compared to the Fiveco figures of 3.80 and 6.36. The jobs faced by Fiveco females are also slightly less demanding in relation to "things" with a value of Y_{15} at 4.62 compared to a value of Y_{15} of 4.56 for female workers in the Des Moines FEA.

In Table 15, we find that estimated total earnings taken over the 13 occupational categories for males is $1,747,531,000 of which $708,403,000 is allocated to cognitive inputs, $637,091,000 to affective inputs, $203,743,000 to psychomotor inputs, and $198,287,000 to gross motor inputs.

Table 15. Tentative ascriptions of 1969 total earnings to four kinds of behavior inputs: male workers 16 years old and over, Des Moines BEA economic area, 1970

Occupational category	N_1 Number of male workers	N_1X_1 (\$1,000)	$N_1X_{1\cdot cog}$ (\$1,000)	$N_1X_{1\cdot aff}$ (\$1,000)	$N_1X_{1\cdot psm}$ (\$1,000)	$N_1X_{1\cdot gm}$ (\$1,000)
1. Teachers, elem. and sec.	2,946	28,213	11,535	14,461	604	1,612
2. Professional, technical	20,814	280,594	136,865	105,633	23,915	14,181
3. Managers, administrators	24,131	330,329	148,196	155,194	9,411	17,526
4. Sales workers	13,300	142,780	62,384	63,017	4,837	12,543
5. Clerical	12,913	104,212	48,828	34,828	9,702	10,853
6. Craftsmen, construction	9,512	81,300	33,415	19,081	17,735	11,070
7. Mechanics, repairmen	4,573	36,919	15,577	8,945	7,511	4,886
8. Other craftsmen	18,918	172,795	80,969	35,426	35,895	20,505
9. Operatives (incl. transp. equip.)	33,788	250,562	74,959	90,197	44,195	41,208
10. Laborers (excl. farm)	12,162	73,877	17,484	26,482	7,150	22,402
11. Farmers and farm workers	28,298	158,062	52,241	47,251	31,448	26,852
12. Service workers	13,956	87,467	25,849	35,753	11,274	14,591
13. Private household workers	127	421	102	194	67	58
TOTAL, all occupations	195,438	1,747,531	708,403	637,091	203,743	198,287
Larger aggregates:						
Upper white collar (2,3)	44,945	610,923	285,060	260,827	33,326	31,707
Lower white collar (1,4,5)	29,159	275,205	122,747	112,306	15,143	25,008
Upper blue collar (6,7,8)	33,003	291,014	129,961	63,452	61,141	36,462
Lower blue collar (9,10,12,13)	60,033	412,327	118,394	152,985	62,685	78,259
Farmers and farm workers (11)	28,298	158,062	52,241	45,521	31,448	26,852
TOTAL, all occupations	195,438	1,747,531	708,403	637,091	203,743	198,287
Proportion of total earnings		1.000	.405	.365	.117	.113
Dollars per worker		\$8,942	\$3,622	\$3,264	\$1,046	\$1,010

In terms of the larger aggregates, the upper white collar (UWC) category accounts for $610,923,000, the lower white collar (LWC) category for $275,205,000, the upper blue collar (UBC) category for $291,014,000, the lower blue collar (LBC) category for $412,327,000, and farmers and farm workers for $158,062,000.

Computed total earnings per worker is $8,942; of this we attribute $3,622 to cognitive inputs, $3,264 to affective behavior, $1,046 to psychomotor behavior, and $1,010 to gross motor activity.

Table 16 presents similar information for the Des Moines FEA. Computed total earnings in the Des Moines FEA as of 1970 stands at $1,176,853,000. Cognitive behavior is assigned $485,810,000, affective behavior $433,816,000, psychomotor behavior $129,976,000, and gross motor activity $127,246,000.

On a per worker basis, the computed figures are $9,300 for total earnings, $3,841 for cognitive inputs, and $3,432, $1,023, $1,004 for affective behavior, psychomotor behavior, and gross motor activity, respectively.

In terms of the larger aggregates, the UWC group is assigned $452,840,000, the LWC $201,559,000, and the UBC and LBC $196,799,000 and $268,078,000, respectively. Farmers and farm workers are assigned $57,577,000.

Tables 17 and 18 give similar information for females with 11 occupational categories. The larger aggregates in Tables 17 and 18 are

Table 16. Tentative ascriptions of 1969 total earnings to four kinds of behavior inputs: male workers 16 years old and over, Des Moines FEA, 1970

Occupational category	N_1 Number of male workers	N_1X_1 ($1,000)	$N_1X_{1 \cdot cog}$ ($1,000)	$N_1X_{1 \cdot aff}$ ($1,000)	$N_1X_{1 \cdot psm}$ ($1,000)	$N_1X_{1 \cdot gm}$ ($1,000)
1. Teachers, elem. and sec.	1,928	18,464	7,549	9,464	395	1,055
2. Professional, technical	16,345	220,347	107,478	82,953	18,780	11,136
3. Managers, administrators	16,984	232,493	104,304	109,229	6,623	12,336
4. Sales workers	9,637	103,457	45,202	45,661	3,505	9,089
5. Clerical	9,868	79,638	37,314	26,615	7,414	8,294
6. Craftsmen, construction	6,184	52,856	21,724	12,405	11,530	7,197
7. Mechanics, repairmen	3.141	25,358	10,699	6,144	5,159	3,356
8. Other craftsmen	12,983	118,585	55,567	24,312	24,634	14,072
9. Operatives (incl. transp. equip.)	21,212	157,302	47,059	56,625	27,745	25,870
10. Laborers (excl. farm)	7,949	48,285	11,428	17,543	4,673	14,642
11. Farmers and farm workers	10,308	57,577	19,030	17,310	11,455	9,781
12. Service workers	9,937	62,279	18,405	25,457	8,027	10,389
13. Private household workers	64	212	51	98	34	29
TOTAL, all occupations	126,540	1,176,853	485,810	433,816	129,976	127,246
Larger aggregates:						
Upper white collar (2,3)	33,329	452,840	211,782	192,182	25,404	23,471
Lower white collar (1,4,5)	21,433	201,559	90,066	81,740	11,314	18,437
Upper blue collar (6,7,8)	22,308	196,799	87,990	42,861	41,323	24,625
Lower blue collar (9,10,12,13)	39,162	268,078	76,943	99,723	40,479	50,930
Farmers and farm workers (11)	10,308	57,577	19,030	17,310	11,455	9,781
TOTAL, all occupations	126,540	1,176,853	485,810	433,816	129,976	127,246
Proportion of total earnings		1.000	.413	.369	.110	.108
Dollars per worker		$9,300	$3,841	$3,432	$1,023	$1,004

Table 17. Tentative ascriptions of 1969 total earnings to four kinds of behavior inputs: female workers 16 years old and over, Des Moines BEA economic area, 1970

Occupational category	N_2 Number of female workers	N_2X_2 (\$1,000)	$N_2X_{2\cdot cog}$ (\$1,000)	$N_2X_{2\cdot aff}$ (\$1,000)	$N_2X_{2\cdot psm}$ (\$1,000)	$N_2X_{2\cdot gm}$ (\$1,000)
1. Teachers, elem. and sec.	7,493	53,737	27,790	21,785	1,134	3,026
2. Professional, technical	11,269	77,204	42,986	23,620	5,431	5,167
3. Managers, administrators	4,765	32,408	17,500	12,272	916	1,721
4. Sales workers	8,367	32,334	17,290	10,810	1,190	3,044
5. Secretaries, stenos, typists	13,771	73,579	33,958	22,024	14,398	3,199
6. Other clerical	28,943	141,040	72,931	39,985	17,913	10,214
7. Operatives (incl. transp. equip.)	9,107	39,722	14,049	12,519	7,058	6,096
8. Other blue collar	3,455	17,434	8,307	3,918	2,701	2,509
9. Farmers and farm workers	1,557	4,348	1,331	1,196	926	896
10. Service workers	25,168	87,282	36,776	27,475	9,373	13,460
11. Private household workers	4,547	7,546	2,048	3,226	1,192	1,080
TOTAL, all occupations	118,442	566,634	274,963	179,029	62,230	50,411
Larger aggregates:						
Upper white collar (1,2,3)	23,527	163,349	88,275	57,677	7,481	9,913
Lower white collar (4,5,6)	51,081	246,953	124,178	72,819	33,500	16,457
Upper blue collar (8)	3,455	17,434	8,307	3,918	2,701	2,509
Lower blue collar (7,10,11)	38,822	134,550	52,872	43,419	17,623	20,636
Farmers and farm workers (9)	1,557	4,348	1,331	1,196	926	896
TOTAL, all occupations	118,442	566,634	274,963	179,029	62,230	50,411
Proportion of total earnings		1.000	.485	.316	.110	.089
Dollars per worker		\$4,784	\$2,320	\$1,512	\$526	\$426

Table 18. Tentative ascriptions of 1969 total earnings to four kinds of behavior inputs: female workers 16 years old and over, Des Moines FEA, 1970

Occupational category	N_2 Number of female workers	N_2X_2 ($1,000)	$N_2X_{2\cdot cog}$ ($1,000)	$N_2X_{2\cdot aff}$ ($1,000)	$N_2X_{2\cdot psm}$ ($1,000)	$N_2X_{2\cdot gm}$ ($1,000)
1. Teachers, elem. and sec.	4,753	34,086	17,628	13,819	720	1,919
2. Professional, technical	8,565	58,679	32,671	17,952	4,128	3,927
3. Managers, administrators	3,332	22,662	12,237	8,582	640	1,203
4. Sales workers	5,751	22,224	11,884	7,430	818	2,092
5. Secretaries, stenos, typists	10,913	58,309	26,910	17,453	11,410	2,535
6. Other clerical	21,893	106,685	55,166	30,245	13,550	7,726
7. Operatives (incl. transp. equip.)	5,290	23,073	8,160	7,272	4,100	3,541
8. Other blue collar	2,280	11,505	5,482	2,585	1,782	1,656
9. Farmers and farm workers	446	1,246	381	342	265	257
10. Service workers	15,758	54,649	23,026	17,328	5,868	8,427
11. Private household workers	2,747	4,559	1,237	1,949	720	652
TOTAL, all occupations	81,728	397,677	194,782	124,957	44,000	33,936
Larger aggregates:						
Upper white collar (1,2,3)	16,650	115,427	62,536	40,353	5,483	7,050
Lower white collar (4,5,6)	38,557	187,218	93,960	55,129	25,777	12,353
Upper blue collar (8)	2,280	11,505	5,482	2,585	1,782	1,656
Lower blue collar (7,10,11)	23,795	82,281	32,423	26,548	10,688	12,621
Farmers and farm workers (9)	446	1,246	381	342	265	257
TOTAL, all occupations	81,728	397,677	194,782	124,957	44,000	33,936
Proportion of total earnings		1.000	.490	.314	.111	.085
Dollars per worker		$4,866	$2,384	$1,528	$540	$414

also comparable to the larger aggregates in Tables 15 and 16. In Table 17, computed total earnings for females in the Des Moines BEA Economic Area as a whole are $566,634,000, only 32.4 percent of the figure for males. Computed total earnings per female worker is $4,784, about 53.5 percent of the figure for males. Together, Tables 15 and 17 give computed total earnings in the entire BEA Economic Area as $1,747,531,000 + $566,634,000 = $2,314,165,000.[1]

Table 19 compares the total earnings figures for both males and females as well as the proportions allocated to cognitive inputs, affective behavior, psychomotor behavior, and gross motor behavior for males and females by subarea as well as for the Des Moines BEA Economic Area as a whole.

Table 20 gives the comparison for mean yearly earnings and mean hourly earnings for males and females by subarea and in the entire BEA Economic Area and also compares their allocations to cognitive inputs, affective behavior, psychomotor behavior, and gross motor activity.

The tables we have displayed for the U.S. and for the Des Moines BEA Economic Area and its subareas are reproducible for other regions in the U.S. There are lots of published data in the U.S. about occupations and earnings, and these are the data on which we have drawn in our

---

[1]The official BEA estimate for the Des Moines BEA Economic Area is $2,204,184,000 for "total labor and proprietors income by place of work" in 1969. See Local Area Personal Income, 1969-1974, published in June, 1976.

Table 19. Tentative ascriptions of 1969 total earnings to four kinds of behavior inputs: male and female workers 16 years old and over, Des Moines BEA economic area and its subareas, 1970

Variables	Total Earnings: Des Moines BEA economic area ($1,000)	Des Moines FEA ($1,000)	MTP subarea ($1,000)	Ottumwa FEA ($1,000)
	I. Male workers			
N_1X_1	1,747,531	1,176,853	173,269	303,453
$N_1X_{1 \cdot cog}$	708,403	485,810	68,479	118,091
$N_1X_{1 \cdot aff}$	637,091	433,816	61,506	108,609
$N_1X_{1 \cdot psm}$	203,743	129,976	22,302	38,811
$N_1X_{1 \cdot gm}$	198,287	127,246	20,981	37,940
	II. Female workers			
N_2X_2	566,634	397,677	50,086	91,269
$N_2X_{2 \cdot cog}$	274,963	194,782	23,886	43,323
$N_2X_{2 \cdot aff}$	179,029	124,957	15,977	29,246
$N_2X_{2 \cdot psm}$	62,230	44,000	5,409	9,814
$N_2X_{2 \cdot gm}$	50,411	33,936	4,815	8,886
	III. Related variables			
N_1	195,438	126,540	20,509	36,418
N_2	118,442	81,728	10,904	19,647
$N_1 + N_2$	313,880	208,268	31,413	56,065
Total population (P)	782,792	502,206	80,026	153,825
Employment as percent of population	40.10	41.47	39.25	36.45
$N_1/(N_1 + N_2)$	.623	.608	.653	.650
$(N_1X_1 + N_2X_2)$	2,314,165	1,574,530	223,355	394,722
$(N_1X_1 + N_2X_2)/(N_1 + N_2)$	7,373	7,560	7,110	7,040
$(N_1X_1 + N_2X_2)/P$	2,956	3,135	2,791	2,566

	Proportions of total earnings					
Fiveco subarea ($1,000)	Des Moines BEA economic area	Des Moines FEA	MTP subarea	Ottumwa FEA	Fiveco subarea
93,959	1.000	1.000	1.000	1.000	1.000
36,022	.405	.413	.395	.389	.383
33,160	.365	.369	.355	.358	.353
12,654	.117	.110	.129	.128	.135
12,121	.113	.108	.121	.125	.129
27,602	1.000	1.000	1.000	1.000	1.000
12,971	.485	.490	.477	.475	.470
8,849	.316	.314	.319	.320	.321
3,008	.110	.111	.108	.108	.109
2,773	.089	.085	.096	.097	.100
11,971					
6,163					
18,134					
46,735					
38.80					
.660					
121,561					
6,703					
2,601					

Table 20. Tentative ascriptions of 1969 mean yearly and mean hourly earnings to four kinds of behavior inputs: male and female workers 16 years old and over, Des Moines BEA economic area and its subareas, 1970

Variables	Male workers			
	Des Moines BEA economic area (dollars)	Des Moines FEA (dollars)	MTP subarea (dollars)	Ottumwa FEA (dollars)
	I. Mean yearly earnings			
X_1, X_2	8,942	9,300	8,448	8,333
$X_{1\cdot cog}$, $X_{2\cdot cog}$	3,622	3,841	3,339	3,243
$X_{1\cdot aff}$, $X_{2\cdot aff}$	3,264	3,432	2,999	2,982
$X_{1\cdot psm}$, $X_{2\cdot psm}$	1,046	1,023	1,087	1,066
$X_{1\cdot gm}$, $X_{2\cdot gm}$	1,010	1,004	1,023	1,042
	II. Mean hourly earnings			
X_{17}, X_{18}	4.16	4.35	3.90	3.85
$X_{17\cdot cog}$, $X_{18\cdot cog}$	1.68	1.80	1.54	1.50
$X_{17\cdot aff}$, $X_{18\cdot aff}$	1.52	1.61	1.38	1.38
$X_{17\cdot psm}$, $X_{18\cdot psm}$	0.49	0.48	0.50	0.50
$X_{17\cdot gm}$, $X_{18\cdot gm}$	0.47	0.47	0.47	0.48

	Female workers				
Fiveco subarea (dollars)	Des Moines BEA economic area (dollars)	Des Moines FEA (dollars)	MTP subarea (dollars)	Ottumwa FEA (dollars)	Fiveco subarea (dollars)
7,849	4,784	4,866	4,593	4,645	4,479
3,009	2,320	2,384	2,191	2,205	2,105
2,770	1,512	1,528	1,465	1,489	1,436
1,057	526	540	496	500	488
1,012	426	414	442	452	450
3.56	2.74	2.79	2.64	2.66	2.57
1.36	1.33	1.37	1.26	1.26	1.21
1.26	0.87	0.88	0.84	0.85	0.82
0.48	0.30	0.31	0.29	0.29	0.28
0.46	0.24	0.24	0.25	0.26	0.26

calculations of total earnings. Also, the approach we have taken in this dissertation adds something to our knowledge of the labor market by (tentatively) quantifying four categories of behavior inputs such that some of the earnings differentials between occupations are attributed to differences in the input vectors required.

Our approach may be relatively much more important in attributing dollar values to nonmarket activities of all age groups based on the estimated market values of the behavior inputs they use in those activities.

With a little bit of special computer programming to incorporate our X and Y variables and the allocating equations in Chapter III of this dissertation, the U.S. Bureau of the Census could take its 1970 data tapes on employment in every county in the U.S., every census tract, and any aggregates of counties or tracts (BEA Economic Areas, SMSAs, NMRs, states, or FEAs) and print out the same tables that we have displayed for the U.S. and the Des Moines BEA Economic Area and its subareas for each of the other regions of interest.

However, this would not be a good idea until there has been a good deal of discussion between Fox, Census Bureau experts, experts on the DOT-HAJ system, and some other scientists (psychologists, physiologists, sociologists, manpower economists, and perhaps others) to check the scientific validity of our behavior input categories, the optimality of our handling of the DOT and Census data, and our allocation procedures, to mention only a few problems on which additional work is needed.

So, in the sense of reproducibility, our procedures are operational. Given employment and earnings vectors for any area in the U.S. or for the U.S. as a whole, we can compute total earnings and allocate them exhaustively to the four categories of behavior inputs already discussed.

V. CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

A very recent paper by Fox (1979a) describes his present approach to social accounts in a series of numbered statements:

> 1. The <u>environment</u> of human behavior in a given year is exhaustively partitioned into spatio-temporal entities called <u>behavior settings</u> (see Barker, 1963, 1968).
>
> 2. No human behavior occurs outside of a behavior setting. Hence, a comprehensive array of behavior settings for the world as a whole in a given year contains <u>all</u> human behavior.
>
> 3. Since all human behavior occurs in behavior settings, any measurable changes or differences in behavior over time or between places must be measurable in behavior settings.
>
> 4. The behavioral contributions or inputs to a behavior setting by its occupants are made through <u>behavior mechanisms</u> (see Barker, 1968). These can be grouped exhaustively into four categories or domains: cognitive, affective, psychomotor, and gross motor (see, for example, Bloom, ed., 1956, Krathwohl et al., 1964, Harrow, 1972, and Durnin and Passmore, 1967).
>
> 5. To the extent that occupants of a setting contribute behavior inputs to it voluntarily, they may be assumed to receive rewards from the setting roughly equal in value to that of their behavior inputs. Hence, if equivalent dollar values can be attributed to the behavior inputs, the same values can be attributed to the rewards. The justification for this assumption is stated rigorously in connection with the Fox-Van Moeseke model (1973, 1974).
>
> 6. In any behavior setting, it is possible to assign a numerical rating to each of the four categories of behavior mechanisms based on the <u>tempo</u> and <u>intensity</u> with which it is used in

implementing the program or standing behavior pattern of the setting and the proportion of total occupancy time in person-hours during which it is so used (the extent of participation among the setting's occupants), as described in Barker (1968). In principle, ratings for the setting as a whole are weighted averages of the corresponding ratings for its individual occupants who may be playing different roles requiring different combinations of inputs.

7. The demands imposed by each role in a setting on the behavior mechanisms of its occupant may be expressed as a vector of four numerical ratings (one for each of the four categories) called a standard behavior input vector or y-vector; each element in the vector has the dimension "quantity required per unit of time spent in the setting."

8. In principle, a y-vector can be specified for each role in an exhaustive set of classes of similar behavior settings called genotypes; all behavior settings in a genotype share a common program, or standing pattern of behavior (e.g. Barber Shops is a genotype, Jones' Barber Shop is a behavior setting), as stated in Barker (1968).

9. In the United States, reasonable proxies for such y-vectors can be derived from the *Dictionary of Occupational Titles* or DOT (1965) and its *Supplement* (1966) for what Berwitz (1975, p. 44) calls "the 14,000 basic jobs comprising the nation's economy." As the 14,000 include professional athletes and performing artists, chauffeurs, housekeepers, and others who do for pay what most people undertake for exercise, prestige, recreation, or do-it-yourself economy, few roles in nonmarket organizations (including households) are without counterparts in the DOT and even those could be rated by an adaptation of job analysis methods, as described in the *Handbook for Analyzing Jobs* (1972).

10. The time, t, spent by each role-occupant in a setting can be multiplied by each element in the appropriate y-vector to obtain a q-vector each element of which has the dimension "quantity" or units of behavior input. The elements of these

quantity vectors can be summed over the occupants of a behavior setting, or across the behavior settings used by an individual in the course of a year, or both.

11. The four elements in a q-vector will be stated in different, probably incommensurable, units. This poses an index number problem: if setting i absorbs more q_1 but less q_2 than setting j, which absorbs the larger total amount of behavior inputs? We cannot say unless we are willing to assign "prices" or other (relative) weights per unit to each of the behavior input categories.

12. In countries with highly developed labor markets, it is possible on certain assumptions to estimate a price vector, p, by regressing the yearly or hourly earnings of workers in an exhaustive set of occupations upon the four elements of their respective q-vectors or y-vectors. If the four prices imply that a specified standard behavior input vector is worth $5.00 an hour in the labor market, the same vector may be given an imputed value of $5.00 an hour when it occurs in nonmarket settings.

13. Given exhaustive sets of standard behavior input vectors y, time-allocation vectors t, and a price vector p, it is possible to compute equivalent dollar values for all behavior inputs supplied in a given year by each population subgroup to each genotype or other aggregate of behavior settings. An illustrative calculation for a particular region in the United States as of 1969 led to an estimate of the total value of behavior inputs supplied to all settings by all residents approximately five times as large as the value supplied to the labor market alone.

In principle, such calculations should lead to consistent valuations of the contributions of different population subgroups to the same categories of behavior settings and to the totalities of the behavior settings they respectively occupy.

14. The behavior stream of any individual is structured into entities of relatively brief duration called behavior episodes, as described in Barker and

> Wright (1955) and Barker (1963). Behavior episodes are ecological units smaller in spatio-temporal extent than behavior settings and always occurring within them. In principle, all behavior occurring in a setting can be partitioned into behavior episodes; this approach may be useful in refining comparisons between similar behavior settings and between similar occupations or roles.

Fox goes on to say that:

> These fourteen statements describe the logical sequence we have followed during five years of work on a project entitled Measurement and Valuation of Social System Outcomes. Each link in the sequence poses researchable problems the solutions of which will require cooperation between experts in at least two data systems and at least two sciences, and validation of the sequence as a whole will require communication among all those involved in any of the links.

At the Social Science Research Council workshop on Social Accounting Systems (March 24-26, 1980) Fox presented a major paper (Fox and Ghosh, 1980) repeating these points and illustrating them at considerable length. At the same workshop, Richard Ruggles' (1980) paper summarized the conceptual and empirical strengths and limitations of demographic and time-based accounts as described in the commissioned papers by Richard Stone, Fox, Thomas Juster, Kenneth Land, Nestor Terleckyj, and Marcus Felson. Ruggles commented as follows on Fox's approach:

> The concept of the space-time behavior setting can provide a comprehensive basis for classifying and analyzing human behavior. There is considerable validity in the proposition that accounts drawn up on this basis do delineate the human activity of a society, and that differences observed over time and space can reveal how a given society changes with the passage of time or how the pattern of life in different countries varies. Certainly this vision of social accounting is on a grand scale worthy of Darwin, Marx and Veblen p. 11).

Ruggles goes on to point out that the approach involves complex linkages between major bodies of data and would be quite difficult to implement on a large scale. (The same could have been said in the 1920's about proposals to develop the existing national income and product accounts or in the 1950's about proposals to develop annual estimates of personal income, and of labor and proprietors income by industry of origin, at the county level--estimates which have been published routinely since 1976.) He also states that "conceivably some more summary version could be built up on the basis of other kinds of information as suggested by the authors" (p. 23), (including published data on employment and hours worked, school enrollments, traffic counts, and benchmark sample surveys of time use in households at intervals of perhaps five years), "but it is not at all clear at this stage just what such accounts would look like and what they would contain" (Ruggles, 1980, p. 23).

In brief, Ruggles has high praise for the conceptual framework developed by Fox and his associates. We believe the descriptive and analytical potentials of the behavior setting approach justify the additional research and data development which will be needed to place it on a firm basis. Eventually, we expect that tables and accounts of publishable quality will result, and that these will coexist for some years with the national income and product accounts. After that, a more complete synthesis of the latter accounts with social accounts and data systems based on the behavior setting approach might be implemented.

In this dissertation we have presented a preliminary set of descriptive tables and social accounts for the U.S. and for the Des Moines

BEA Economic Area and its subareas. We also demonstrated the relationship of computed earnings in the labor market of the Des Moines BEA Economic Area and its subareas to the DOT-HAJ variables which we took as proxies for psychomotor behavior, affective behavior, cognitive behavior, and gross motor behavior.

Comprehensive social accounts for each of a series of years would be of considerable interest as descriptions of trends and fluctuations in the contributions made and rewards received by population subgroups and in various authority systems and categories of time uses. In addition, they would provide the time series from which empirical relationships could be estimated and analytical models constructed. Just as the development of national income accounts provided an impetus to the construction of national econometric models, it is hoped that the proposed system of social accounts if implemented on the level of BEA Economic Areas with possible aggregation to NMRs or disaggregation to FEAs would be an incentive to the building of sociometric (defined to include econometric) models at the BEA, NMR, or FEA level if and when time series and/or cross section data on the variables are available. Such time series and cross section variables can be provided if the proposed accounts are implemented by national statistical agencies. Our objective so far has been to clarify concepts and methods, and we have not aspired now to the level of empirical accuracy that should be attainable in the construction of social accounts a decade hence.

In order to hasten the desired maturation of social accounts we see the need for convergence in the hopes and aspirations of the various agencies which collect and use data for policy purposes. Such a convergence would require further research on the linking of micro and macro data sets and a desire to improve existing data bases.

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Last but most, I thank my wife, Helen, and our daughter, Nyimeawia, for bearing with me the cycles of graduate school. The patience and smiles of Helen and Nyimeawia did a lot to encourage and sustain me in the writing phase of this dissertation.

VIII. APPENDIX A: A RESUMÉ OF THE PROPERTIES OF OUR DATA SET AND IMPROVEMENTS MADE POSSIBLE BY THE DICTIONARY OF OCCUPATIONAL TITLES, FOURTH EDITION (1977)

A. Data Set Based on the Dictionary of Occupational Titles, Third Edition (1965) and its Supplements

Barker and Gump (1964, pp. 187-192) used the DOT Second Edition (1949) to determine that most of the roles performed by Midwest's adolescents in 1958-59, whether paid or unpaid, were "standard occupations in American culture". They listed 77 occupations (actress, athlete, clerk-typist, painter, salesperson, waitress, window cleaner, and the like) which accounted for 86 percent of the roles by number and a much larger percent of the total time spent in them. The remaining roles were brief and infrequent ones such as wedding attendant or award recipient.

Barker and Gump had no thought of converting DOT 2 into a data set. In using it, however, they recognized that the DOT was classifying a subset of the human activities that Barker was observing and rating in behavior settings. Appendix Table A1 is reproduced from part of Table 11.5 in Barker and Gump (1964, p. 188) to highlight this point. Appendix Table A1 also shows the connection between DOT classifications and Barker's behavior setting surveys.

The Third Edition (1965), which we shall refer to as DOT 3, contained major innovations. The most important for our purposes was the classification of worker functions into levels of complexity in relation to <u>data</u> <u>people</u>, and <u>things</u> in that order. The complete array of these

Table A1. Performances engaged in by the high school students of Midwest classified according to the Dictionary of Occupational Titles (Barker and Gump, 1964, p. 188)

DOT Classification	Code No.	Setting Class	No. of Settings	Examples of Settings
Actor and Actress	0-02.11(15)	3	2	H.S. Senior Class Play
		4	6	Amateur Program, Old Settlers
Athlete	0-57.01	3	11	H.S. Football Games
		4	2	Town Team Baseball Games
Announcer	0-69.22	3	1	H.S. Football Games
		4	0	
Automobile Service Station Attendant	7-60.50	3	0	
		4	3	Bethel Service Station°
Bus Boy	2-29.51	3	1	Presbyterian Covered Dish Supper
		4	2	Father-Son Banquet
Butcher Helper	9-59.01	3	0	
		4	1	Kane's Grocery°
Buyer I (Collector: Used Clothing)	1-61.60	3	0	
		4	1	H.S. Home Economics Bundle Day Program
Cashier II	1-01.53	3	0	
		4	3	Old Settlers Reunion—Midway°
Character Men (Pantomime)	0-02.11	3	0	
		4	1	Mother-Daughter Banquet
Character Man	0-02.11(15)	3	0	
		4	2	School Christmas Vespers
Child Monitor	2-07.01	3	0	
		4	2	Presbyterian Nursery during Church
Chorus Girl (Cheerleader)	0-45.21	3	8	H.S. Basketball Games
		4	0	
Cleaner III	9-85.02	3	0	
		4	3	Junior Class Car Wash
Clergyman (Worship Leader)	0-08.10	3	6	Westminster Fellowship Retreat
		4	1	Methodist Easter Sunrise Service
Clerk, General Office	1-05.01	3	0	
		4	1	Chest Unit X-Ray

° Employment for pay.

CHART 1
WORKER FUNCTIONS

Data		People		Things	
0	Synthesizing	0	Mentoring	0	Setting Up
1	Coordinating	1	Negotiating	1	Precision Working
2	Analyzing	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-Signaling	6	Feeding-Offbearing
		7	Serving	7	Handling
		8	Taking Instructions, Helping		

Chart 1. Worker functions (Berwitz, 1975, p. 46)

levels of complexity is shown in Chart 2, based on Berwitz (1975, p. 48).

The classification of occupations in DOT 3 is generally comparable with the classification of occupations in the U.S. Census. For example, the first three digit classification in the DOT 3 identifies the occupational category. A relevant example of a three-digit code group is "152, Occupations in Music". Here the first digit (1) states that the job is professional, technical, or managerial. The two digits (15) stand for "Occupations in Entertainment and Recreation" and the third digit (2) means that the three-digit code group entitled "Occupations in Music" is the third (0 being the first) code group listed for the two-digit division "15". The second three-digit classification for an instrumentalist or a musician is .048 where "0" represents the Synthesizing level for DATA,"4" represents the Diverting level for PEOPLE and "8" represents no significant relationship to THINGS. Thus the full DOT 3 code for a musician is 152.048.

On page 47 of Berwitz, he states that "the elements listed . . . for DATA and THINGS comprise hierarchies: each level assumes that a worker who performs at that level can perform the tasks associated with each lower level, actually or potentially. Thus a worker who can function under the rubric "Analyzing" is assumed to be able to Compile, Compute, Copy, and Compare. The levels for PEOPLE are hierarchies only in a general sense: Mentoring (advising, counseling) is a higher function than Persuading or Negotiating and may or may not involve the other two. Instructing is not necessarily higher than Supervising and therefore does not have a hierarchical relationship to it. Serving, however, is a lower level of complexity."

Evidently, each step up the DATA hierarchy from Comparing to Synthesizing is viewed as requiring more training and/or cognitive ability; hence, we should expect that each step upward would be associated with higher remuneration. The same expectations apply to each step up the THINGS hierarchy from Handling to Setting Up in terms of psychomotor skills. There is some ambiguity about the consequences of individual steps in the PEOPLE hierarchy, but it is clear that Mentoring and Negotiating are more demanding and better paid than Serving and Speaking-Signaling.

Since it will be easier to talk about the relations of worker functions to earnings in a positive sense, we have transformed the code numbers in Chart 2 as follows:

Z_{13} = 7 - DATA code number

Z_{14} = 9 - PEOPLE code number

Z_{15} = 8 - THINGS code number

Thus, Z_{13} has a value of 7 for Synthesizing and of 1 for Comparing, Z_{14} has a value of 9 for Mentoring and 2 for Serving; and Z_{15} has a value of 8 for Setting Up and 1 for Handling.

We should expect a positive association between each of these variables and earnings over the range of civilian occupations. The intervals between successive values of (say) Z_{13} may not be identical and the relationship between earnings (X_1) and Z_{13} may not be linear. However, the assumptions of equal intervals and linear relationships have the advantage of simplicity, and the results obtained under them can be compared with the results of alternative assumptions.

In the text of the dissertation we use these simplifying assumptions to the exclusion of others. However, alternative assumptions were tested by Fox in April 1979 in a data set from which all code numbers of 7 or 8 for DATA and 8 for PEOPLE and THINGS were excluded as "unreal". Thirty occupations out of the 460 in our data set (farming and private household occupations and few others) were discarded and the remaining 430 partitioned into five groups. One group of 38 occupations contained "real" values only for DATA; another group of 86 occupations contained "real" values only for THINGS.

1. Alternative relationships between earnings (X_1) and levels of job complexity with respect to DATA (Z_{13})

The simple regression of X_1 on Z_{13} in the group of 38 occupations is:

$$X_1 = \$4,381 + \underset{(185)}{1338} Z_{13};$$

$$\bar{r}^2 = .5795; \quad \bar{S} = \$2128 \qquad \text{(A-1)}$$

As an alternative, each of the seven levels of complexity represented was treated as a separate "qualitative" variable. In this setup, the estimated value of X_1 associated with a given value of Z_{13} is the mean of earnings in the various occupations with that level of complexity in relation to data, as follows:

(1) Level of Complexity (Z_{13})	(2) Mean Earnings (X_1)	(3) Interval Between Successive Means	(4) Estimate of $\hat{X}_1$ from Equation A-1
7	$14,139	--	$13,747
6	12,333	$1,806	12,409
5	11,174	1,159	11,071
4	9,297	1,877	9,733
3	8,786	511	8,395
2	7,747	1,039	7,057
1	7,409	338	5,719

The group-mean earnings in Column (2) increase monotonically from $Z_{13} = 1$ to $Z_{13} = 7$, and they do not differ greatly from the values of $\hat{X}_1$ in Column (4) which are estimated from Equation A-1. When viewed as a regression equation with six independent variables, the alternative "qualitative" setup yields an $\bar{R}^2 = .5825$, only microscopically larger than that associated with the linear regression ($\bar{r}^2 = .5795$) and a standard error of estimate ($2120) only microscopically smaller.

2. Alternative relationships between earnings (X_1) and levels of job complexity with respect to THINGS (Z_{15})

The simple regression of X_1 on Z_{15} in the group of 86 occupations previously mentioned is:

$$X_1 = \$6065 + \underset{(72)}{286} Z_{15};$$

$$\bar{r}^2 = .1489; \quad \bar{S} = \$2188 \qquad \text{(A-2)}$$

The t-ratio associated with the regression coefficient is 3.98. On the average, an increase of one unit in job complexity with respect to THINGS is associated with a \$286 increase in earnings. This is the basis for the rounded coefficient of \$300 which we imposed on Z_{15} in our text equation for allocating the earnings of male workers among four categories of behavior inputs.

The 86 values of Z_{15} were distributed among seven levels of complexity. An alternative "qualitative" regression setup yielded an $\bar{R}^2 = .1353$ and a standard error of estimate of \$1298, respectively slightly smaller and slightly larger than those associated with the linear regression equation A-2. The group-mean values of X_1 increase almost monotonically (except for one reversal) with successively higher levels of job complexity, as shown below:

(1) Level of Complexity (Z_{15})	(2) Mean Earnings (X_1)	(3) Interval Between Successive Means	(4) Estimate of $\hat{X}_1$ from Equation A-2
7	\$8,142	--	\$8,068
6	7,532	\$610	7,781
5	7,233	299	7,495
4	7,615	-382	7,209
3	6,815	800	6,923
2	6,288	527	6,637
1	6,256	32	6,351

With an average of 12.3 occupations per level of complexity, the group means in Column (2) have some stability and do not differ greatly from the corresponding regression estimates of earnings ($\hat{X}_1$) in Column (4) derived from Equation A-2.

A similar analysis was made of the relationship of earnings to job complexity with respect to PEOPLE. The relevant subset contains only 27 occupations: 19 of these are at level $Z_{14} = 2$, Serving, six at $Z_{14} = 3$, Speaking-Signaling, and two at $Z_{14} = 4$, Persuading. The simple regression of earnings on complexity is:

$$X_1 = \$3,285 + \underset{(552)}{1124} Z_{14} \;;$$

$$\bar{r}^2 = .1078 \qquad \text{(A-3)}$$

The magnitude and sign of the regression coefficient are in line with expectations but the standard error of the coefficient is large and the t-ratio only 2.04.

The group mean earnings are

(1) Level of Complexity (Z_{14})	(2) Mean Earnings (X_1)
4	\$6,013
3	7,834
2	5,347

The progression of group means is erratic, and the one associated with $Z_{14} = 4$ is based on two observations.

B. Improvements in the Data Set Made Possible by Information in the *Dictionary of Occupational Titles, Fourth Edition* (1977)

The Fourth Edition of the *Dictionary of Occupational Titles*, which we refer to as DOT 4, eliminates the "not significant" ratings used in DOT 3. DOT 3 assigned values of 8 to PEOPLE and THINGS, and of 7 or

8 to DATA, in many occupations with the meaning "no significant relationship"; hence these ratings are not "real" in the sense that they do not signify a level of worker function.

The DOT 4 eliminates all 8's from THINGS and all 7's and 8's from DATA and gives "real" ratings from 0 to 6 on DATA and 0 to 7 on THINGS for every occupation. The same principle applies to all 8's which had been assigned to PEOPLE in the DOT 3. However, the DOT 4 adds a real level 8 to PEOPLE, meaning "Taking instructions- Helping"; hence there are still a good many 8's for PEOPLE in DOT 4 but these 8's are real ratings. In essence, only real ratings are included in the new code numbers for worker functions in DOT 4, as indicated in Chart 1, based on Berwitz (1975, p. 46). Thus, the code numbers for DATA run from 0 to 6, those for THINGS from 0 to 7, and those for PEOPLE from 0 to 8; but the 8 now stands for a real level of job complexity, Taking Instruction-Helping. Chart 1 may be compared to Chart 2 to visualize these improvements.

We became aware of these improvements in DOT 4 only a few weeks ago and have now incorporated them into our data set for the 460 occupations.

CHART 2
WORKER FUNCTION LEVELS IN DOT[a]

	Data[b]		People[b]		Things[b]
0	Synthesizing	0	Mentoring	0	Setting Up
1	Coordinating	1	Negotiating	1	Precision Working
2	Analyzing	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-Signaling	6	Feeding-Offbearing
*7	Not significant	7	Serving	7	Handling
*8	Not significant	*8	Not significant	*8	Not significant

[a] For definitions see *Handbook for Analyzing Jobs*, or Appendices A and B.
[b] Asterisk represents change from Worker Functions listing used for job analysis.

Chart 2. Worker function levels in DOT (Berwitz, 1975, p. 48)

IX. APPENDIX B: EMPIRICAL SUPPORT FOR COEFFICIENTS RELATING EARNINGS TO THE COMPLEXITY OF WORKER FUNCTIONS IN RELATION TO THINGS, AND TO HEAVINESS OF WORK

This appendix reports the results of several regression analyses we made on some 198 Census occupations covering blue collar workers. The occupational groups in the blue collar category are construction workers, mechanics and repairmen, other craftsmen, operatives including transportation, laborers, and service workers.

A. Relationship between Earnings and the Complexity of Worker Function in Relation to Things

One regression equation in which earnings of male workers (X_1) was the dependent variable and the complexity of worker function in relation to things (Z_{15}) was the independent variable yielded the following result:

$$X_1 = 5851.90 + 334.04Z_{15}$$
$$(211.27) \quad (39.43) \qquad \text{(B-1)}$$
$$\bar{r}^2 = .2643; \quad \bar{S} = \$1350.5$$

Equation B-1 associates a unit increment in Z_{15} (complexity of worker function in relation to things) with an increase of about \$334 in the earnings of male workers (X_1). The mean of X_1 over the 198 occupations was \$7446.16 and the mean of Z_{15} was 4.77. The standard deviations are \$1574.42 for X_1 and 2.44 for Z_{15}.

Using Equation B-1 as our starting point, we introduced other variables measuring the complexity of worker functions, namely, the complexity of worker function in relation to data (Z_{13}), the complexity of worker function in relation to people (Z_{14}), and the heaviness of work (Z_1). The equation relating earnings (X_1) to the complexity of worker function in relation to data (Z_{13}) and things (Z_{15}) was:

$$X_1 = \underset{(212.95)}{5695.30} + \underset{(73.38)}{226.47Z_{13}} + \underset{(51.15)}{230.48Z_{15}} \qquad \text{(B-2)}$$

$$\bar{R}^2 = .2949; \quad \bar{S} = \$1322.0$$

and the equation relating earnings to the complexity of worker function in relation to data (Z_{13}), people (Z_{14}), and things (Z_{15}) in these 198 blue collar occupations was:

$$X_1 = \underset{(278.38)}{5617.20} + \underset{(75.60)}{218.79Z_{13}} + \underset{(100.31)}{43.85Z_{14}} + \underset{(52.63)}{235.70Z_{15}} \qquad \text{(B-3)}$$

$$\bar{R}^2 = .2919; \quad \bar{S} = \$1324.80$$

In Equation (B-3), Z_{14} is not significant with a standard error of 100.31 and a t-ratio of 0.44; and its inclusion in Equation B-3 actually reduces $\bar{R}^2$ from .2949 to .2919. When Z_{14} was replaced with heaviness of work (Z_1) we obtained the following equation:

$$X_1 = \underset{(407.35)}{5864.00} + \underset{(73.57)}{225.20Z_{13}} + \underset{(51.27)}{231.08Z_{15}} - \underset{(118.14)}{57.42Z_1} \qquad \text{(B-4)}$$

$$\bar{R}^2 = .2921; \quad \bar{S} = \$1324.6$$

in which the heaviness of work (Z_1) was not significant.

When the complexity of worker function in relation to data (Z_{13}) was dropped from Equation B-4 and the complexity of worker function in relation to people (Z_{14}) as well as the heaviness of work (Z_1) were used as the independent variables together with complexity of worker function in relation to things (Z_{15}), the result obtained was:

$$X_1 = \underset{(458.67)}{5833.70} + \underset{(99.66)}{109.12Z_{14}} + \underset{(39.67)}{338.33Z_{15}} - \underset{(120.62)}{64.85Z_1} \quad \text{(B-5)}$$

$$\bar{R}^2 = .2625; \quad \bar{S} = \$1352.1$$

In Equation B-5, the coefficient for heaviness of work (Z_1) is not significant with a t-ratio of -0.54 while the coefficient for Z_{15} is now 338.33, higher than the coefficient for Z_{15} in Equation B-4.

Finally, when earnings was regressed on all four job-descriptive variables (Z_{13}, Z_{14}, Z_{15}, and Z_1), the result obtained was:

$$X_1 = \underset{(450.65)}{5783.80} + \underset{(75.78)}{217.84Z_{13}} + \underset{(100.57)}{42.27Z_{14}} + \underset{(52.74)}{236.10Z_{15}}$$

$$- \underset{(118.46)}{55.75Z_1} \quad \text{(B-6)}$$

$$\bar{R}^2 = .2891; \quad \bar{S} = \$1327.4$$

The coefficients for Z_1 and Z_{14} in Equation B-6 are not significant while the coefficient for Z_{15} drops about 30 percent from what it was in Equation B-5.

The regression coefficient for Z_{15} remained highly significant in all these regressions with a lowest value of $231.08 in Equation

B-4 and a highest value of \$338.33 in Equation B-5. The value of \$300 imposed on the coefficient of Z_{15} in the text is close to the midpoint (\$285) of this range and is adequate for the exploratory purposes of Chapter III.

B. Relationship between Earnings and the Heaviness of Work

In order to provide empirical support for the imposed coefficient of \$400 on the variable measuring the heaviness of work, we also investigated the values of a regression coefficient relating earnings of male workers (X_1) to strength required in terms of heaviness of work (Z_1). Recall that in Chapter III of the text, our regression analysis involving earnings (X_1) and the four job-descriptive variables (Z_{13}, Z_{14}, Z_{15}, and Z_1) for all 460 occupations estimated a coefficient of -\$600.99 with a standard error of \$126.32 for Z_1. The implausibility of this estimated coefficient for Z_1 both in terms of sign and magnitude led us to further investigation within some 198 occupations covering blue collar workers. These occupations fall into the broad categories of: construction workers, mechanics and repairmen, other craftsmen, operatives including transportation, laborers, and service workers, and they are occupations in which we expect heaviness of work to play a significant role in determining wages and salaries.

First, we regressed X_1 and Z_1 separately on the other three job-descriptive variables Z_{13}, Z_{14}, and Z_{15} and the Census variables median years of schooling (X_5) and median age (X_7) of male workers. The equation relating earnings (X_1) to the five independent variables was estimated as:

$$X_1 = -5509.9 - 80.10Z_{13} - 11.64Z_{14} + 266.66Z_{15}$$
$$(1070.0)\quad (67.87)\qquad (81.99)\qquad (43.54)$$

$$+ 757.57\, X_5 + 89.28X_7$$
$$(80.95)\qquad (11.37) \qquad\qquad (B\text{-}7)$$
$$\bar{R}^2 = .5547; \quad \bar{S} = \$1050.6$$

Interestingly, the coefficients of Z_{13} (data) and Z_{14} (people) are both nonsignificant in Equation B-7; the coefficient of Z_{15} (things) is highly significant at \$266.66, not far from the \$300 we imposed in Chapter III. The coefficients of the two Census variables are also highly significant. The mean of X_1 (earnings) in these 198 occupations was \$7446.2 and the standard deviation was \$1574.4. The means of Z_{13}, Z_{14}, and Z_{15} were (respectively), 2.87, 1.72, and 4.77 and their standard deviations were 1.70, 0.97, and 2.44 in that order.

When the heaviness of work was used as the dependent variable we obtained the following equation:

$$Z_1 - 4.77 + 0.031Z_{13} - 0.020Z_{14} + 0.002Z_{15}$$
$$(0.81)\quad (0.052)\qquad (0.062)\qquad (0.033)$$
$$- 0.122X_5 - 0.0142X_7$$
$$(0.061)\qquad (0.0086) \qquad\qquad (B\text{-}8)$$
$$\bar{R}^2 = .00329; \quad \bar{S} = .798$$

Equations B-7 and B-8 were then used to obtain residuals $x_1 = (X_1-\hat{X}_1)$ where $\hat{X}_1$ was estimated from Equation B-7; and $z_1 = (Z_1-\hat{Z}_1)$ where $\hat{Z}_1$ was estimated from Equation B-8. Then the following equation involving the residuals was fitted. The result obtained was:

$$x_1 = 111.16z_1$$
$$(93.70) \qquad \text{(B-9)}$$
$$\bar{r}^2 = .002064; \quad \bar{S} = \$1036.1$$

Since the means of x_1 and z_1 are both zero; the intercept term is zero. Equation B-9 showed the presence of positive serial correlation with a Durbin-Watson statistic of 1.5442. Hence, we transformed the variables x_1 and z_1 into their first differences and used these first difference variables in a regression equation in which we obtained:

$$\Delta x_1 = -4.06 + 210.96\Delta z_1$$
$$(90.37) \qquad \text{(B-10)}$$
$$\bar{r}^2 = .02219; \quad \bar{S} = \$1286.8$$

Equation B-10 provides a plausible coefficient for the effect of changes in heaviness of work on changes in earnings of male workers and gives some support to our a priori expectation of a positive relationship between heaviness of work and earnings. While our imposition of a coefficient of \$400 on Z_1 (heaviness of work), in rejecting the least squares estimated coefficient of -\$600.99, may be said to use \$1,000 of a priori information, the coefficient of Δz_1 in Equation B-10 reduces the amount of such a priori information required to be less than \$200. In short, considering the fact that the coefficient of \$211 estimated in Equation B-10 is positive lends support to our expectation of a positive relationship between earnings and heaviness of work when other influences on earnings are held constant.

The coefficient of \$400 imposed on Z_1 in the text is nearly twice as large as the coefficient estimated in Equation B-10, so the \$400 still rests in part on an a priori judgment. It should be noted that the occupational group involving the heaviest physical work, namely laborers, has an average Z_1 value of 4.06 and mean earnings (X_1) of \$6,074. Our imposed coefficient of \$400 would attribute \$1,624 of these earnings to Z_1 (heaviness of work) and the remaining \$4,450 to complexity of worker functions relating to data, people, and things and effects of schooling and median age. Since these variables are all at relatively low levels for laborers, our allowance of \$400 per unit increment in heaviness of work does not strike us as unduly large.

Future research should be able to establish a more satisfactory coefficient relating earnings to heaviness of work by, for example, interviewing employees of labor in large organizations as to what remunerations or compensations they pay to workers for heaviness of work.