

The future of the labor force: higher cognition and more skills

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Appendix

S.1 The construction of SOC2010dd taxonomy

The appendix shows the necessity of establishing SOC2010dd, and the crosswalks between SOC2010dd and SOC2018/2010/2000. There are several cases where occupations from two SOC have to be combined into a hybrid occupation.

There are many-to-many issues from the original to the new classification system. For example (see Table S1), 2000 SOC occupation Electricians(47-2111) are crosswalked to two 2010 occupations, including Electricians(47-2111) and solar Photovoltaic Installers(47-2231). Meanwhile, Solar Photovoltaic Installers(47-2231) in 2010 SOC occupation is crosswalked to five 2000 occupations, including Electricians(47-2111), Roofers(47-2181), Construction and Related Workers, All Other(47-4099), Heating, Air Conditioning, and Refrigeration Mechanics and Installers(49-9021) and Installation, Maintenance, and Repair Workers, All Other(49-9099). Also, there are many-to-one issues if an occupation in the initial SOC makes up only part of the occupation in the new SOC; that is, the new SOC's occupation has been created from multiple initial SOC's codes. The one-to-many and many-to-many mapping makes data processing difficult, especially for the sum of employment data. Therefore, combining these one-to-many and many-to-many occupations is necessary to generate a new occupational category. We generated SOC2010dd based on SOC2010. SOC2010dd is a direct aggregation of certain occupations with one-to-one, many-to-one, one-to-many and many-to-many issues (Fig. S1 shows the processing and aggregation of occupations under different SOC systems). Please refer to Table S2 for the crosswalk between SOC2010dd and SOC2000/2010/2018

Table S1: Occupations with many-to-many issue

Soc2000	SocTitle2000	Soc2010	SocTitle2010
47-2111	Electricians*	47-2111	Electricians
47-2111	Electricians*	47-2231	Solar Photovoltaic Installers**
47-2111	Electricians*	47-2231	Solar Photovoltaic Installers**
47-2181	Roofers*	47-2231	Solar Photovoltaic Installers**
47-4099	Construction and Related Workers, All Other*	47-2231	Solar Photovoltaic Installers**
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers*	47-2231	Solar Photovoltaic Installers**
49-9099	Installation, Maintenance, and Repair Workers, All Other*	47-2231	Solar Photovoltaic Installers**

A single asterisk (*) after the occupation code and title in the first column means that the occupation in the second column makes up only part of the occupation in the first column; the asterisked 2000 SOC occupation has been divided into multiple new occupations. Likewise, a double asterisk (**) after the occupation code and title in the second column means that the occupation in the first column makes up only part of the occupation in the second column; that is, the double asterisked

2010 SOC occupation has been created from multiple 2000 SOC codes.

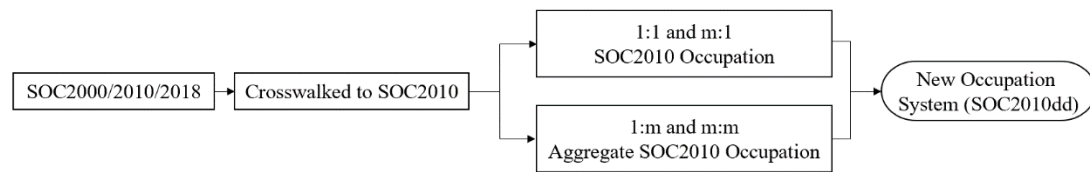


Figure S1: Occupation processing and aggregation under different SOC systems

Figure S1 illustrates the crosswalk from different SOC systems—namely SOC2000, SOC2010, and SOC2018—to SOC2010dd based on SOC2010. The process begins by mapping SOC2018/2000 occupations to SOC2010, which reveals four issues: One-to-one (1:1) issue, where an occupation in SOC2000/2018 corresponds to an occupation in SOC2010. Many-to-one (m:1) issue, where multiple occupations in SOC2000/2018 are aggregated into a single occupation in SOC2010. One-to-many (1:m) issue, where an occupation in SOC2000/2018 is divided into multiple occupations in SOC2010. Many-to-many (m:m) issue, where multiple occupations in SOC2000/2018 are related to multiple occupations in SOC2010. For 1:1 and m:1 issue, the SOC2010 occupation code is adopted. In cases of 1:m and m:m issue, the relevant SOC2010 occupation codes are aggregated into a single composite code. These strategies ensure a coherent transition to the hybrid occupational classification system, SOC2010dd.

Table S2: Crosswalk between SOC2010dd and SOC2000/2010/2018

SOC2010dd	SOC2010	SOC2000	SOC2018
11-1011	11-1011	11-1011	11-1011
11-1021	11-1021	11-1021	11-1021
11-1031	11-1031	11-1031	11-1031
11-2011	11-2011	11-2011	11-2011
11-2021	11-2021	11-2021	11-2021
11-2022	11-2022	11-2022	11-2022
11-2031	11-2031	11-2031	11-2033,11-2032
11-3011	11-3011	11-3011	11-3013,11-3012
11-3021	11-3021	11-3021	11-3021
11-3031	11-3031	11-3031	11-3031
11-3051	11-3051	11-3051	11-3051
11-3061	11-3061	11-3061	11-3061
11-3071	11-3071	11-3071	11-3071
11-3111	11-3111	11-3041	11-3111
11-3121	11-3121	11-3049	11-3121
11-3131	11-3131	11-3042	11-3131
11-9013	11-9013	11-9011,11-9012	11-9013
11-9021	11-9021	11-9021	11-9021
11-9031	11-9031	11-9031	11-9031
11-9032	11-9032	11-9032	11-9032
11-9033	11-9033	11-9033	11-9033
11-9039	11-9039	11-9039	11-9039
11-9041	11-9041	11-9041	11-9041
11-9051	11-9051	11-9051	11-9051
11-9061.11	39-4031,11-9061	11-9061	11-9171,39-4031
11-9071	11-9071	11-9071	11-9071
11-9081	11-9081	11-9081	11-9081
11-9111	11-9111	11-9111	11-9111
11-9121	11-9121	11-9121	11-9121
11-9131	11-9131	11-9131	11-9131
11-9141	11-9141	11-9141	11-9141
11-9151	11-9151	11-9151	11-9151

11-9161	11-9161	13-1061	11-9161
13-1011	13-1011	13-1011	13-1011
13-1021	13-1021	13-1021	13-1021
13-1022	13-1022	13-1022	13-1022
13-1023	13-1023	13-1023	13-1023
13-1031	13-1031	13-1031	13-1031
13-1032	13-1032	13-1032	13-1032
13-1051	13-1051	13-1051	13-1051
13-1074	13-1074	45-1012	13-1074
13-1078.88	13-1071,13-1075	13-1071,13-1079	13-1071,13-1075
13-1081	13-1081	13-1081	13-1081
13-1111	13-1111	13-1111	13-1111
13-1141	13-1141	13-1072	13-1141
13-1151	13-1151	13-1073	13-1151
13-2011	13-2011	13-2011	13-2011
13-2021	13-2021	13-2021	13-2022,13-2023
13-2031	13-2031	13-2031	13-2031
13-2041	13-2041	13-2041	13-2041
13-2052	13-2052	13-2052	13-2052
13-2053	13-2053	13-2053	13-2053
13-2061	13-2061	13-2061	13-2061
13-2071	13-2071	13-2071	13-2071
13-2072	13-2072	13-2072	13-2072
13-2081	13-2081	13-2081	13-2081
13-2082	13-2082	13-2082	13-2082
13-2088.99	13-2051,13-2099	13-2051,13-2099	13-2099,13-2054,13-2051
15-1111	15-1111	15-1011	15-1221
15-1131	15-1131	15-1021	15-1251
15-1151	15-1151	15-1041	15-1232
15-2011	15-2011	15-2011	15-2011
15-2021	15-2021	15-2021	15-2021
15-2031	15-2031	15-2031	15-2031
15-2041	15-2041	15-2041	15-2041
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17-1012	17-1012	17-1012	17-1012
17-1021	17-1021	17-1021	17-1021
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17-2011	17-2011	17-2011	17-2011
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17-2121	17-2121	17-2121	17-2121
17-2131	17-2131	17-2131	17-2131
17-2141	17-2141	17-2141	17-2141
17-2151	17-2151	17-2151	17-2151

17-2161	17-2161	17-2161	17-2161
17-2171	17-2171	17-2171	17-2171
17-2199	17-2199	17-2199	17-2199
17-3011	17-3011	17-3011	17-3011
17-3012	17-3012	17-3012	17-3012
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51-9071	51-9071	51-9071	51-9071
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51-9188.99	51-4012,51-3099,51-4011,51-9199	51-4011,51-9199,51-4012	51-9199,51-9161,51-3099,51-9162
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53-2022	53-2022	53-2022	53-2022
53-2031	53-2031	39-6031	53-2031
53-3011	53-3011	53-3011	53-3011
53-3021	53-3021	53-3021	53-3052
53-3031	53-3031	53-3031	53-3031
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53-3033	53-3033	53-3033	53-3033
53-3059.99	53-3022,53-3041	53-3041,53-3022	53-3051,53-3053,53-3054
53-3099	53-3099	53-3099	53-3099
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53-6051	53-6051	53-6051	53-6051
53-6061	53-6061	39-6032	53-6061
53-6099	53-6099	53-6099	53-6099,53-6032
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53-7121	53-7121	53-7121	53-7121
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55-1015	55-1015	55-1015	55-1015
55-1016	55-1016	55-1016	55-1016
55-1017	55-1017	55-1017	55-1017
55-1019	55-1019	55-1019	55-1019
55-2011	55-2011	55-2011	55-2011
55-2012	55-2012	55-2012	55-2012
55-2013	55-2013	55-2013	55-2013
55-3011	55-3011	55-3011	55-3011
55-3012	55-3012	55-3012	55-3012
55-3013	55-3013	55-3013	55-3013
55-3014	55-3014	55-3014	55-3014
55-3015	55-3015	55-3015	55-3015
55-3016	55-3016	55-3016	55-3016
55-3018	55-3018	55-3018	55-3018
55-3019	55-3019	55-3019	55-3019
85-8888.99	39-1021,53-1031	53-1031,39-1021	39-1022,53-1044,53-1043,53-1049,39-1014
95-8888.99	53-7199,53-7032	53-7199,53-7032	53-7199,47-5022

SOC2010dd aggregates occupations based on SOC2010 to address the one-to-one, many-to-one, one-to-many and many-to-many issues between different SOC systems. After aggregating these occupations, we generate new occupational codes, which meet the following criteria: 1. Uniqueness: The codes do not belong to the occupational codes of SOC2000, SOC2010, and SOC2008; 2. Consistency: They have a uniform format, closely aligning with the major categories (at two digits level) of the merged occupations; 3. Visibility: The aggregated occupation codes are composed of eight digits.

S.2 The relationship between the original scale and those after the transformation

The initial estimate of the dependent variable is denoted as $\hat{Y}_{initial}$, and the estimate after Box-Cox transformation is $\hat{Y}_{transformed}$. The relationship between $\hat{Y}_{initial}$ and $\hat{Y}_{transformed}$ is expressed as:

$$\hat{Y}_{initial} = (\lambda \hat{Y}_{transformed} + 1)^{\frac{1}{\lambda}}$$

Therefore, we have:

$$\frac{\partial \hat{Y}_{initial}}{\partial X} = (\lambda \hat{Y}_{transformed} + 1)^{\frac{1}{\lambda}-1} \cdot \frac{\partial \hat{Y}_{transformed}}{\partial X}$$

In this equation, $\frac{\partial \hat{Y}_{transformed}}{\partial X}$ represents the coefficients presented in Table 4. Consequently, we have:

$$\begin{aligned} \frac{\partial \hat{Y}_{initial}}{\partial X_i} &= \alpha_i (\lambda \hat{Y}_{transformed} + 1)^{\frac{1}{\lambda}-1} \\ \frac{\partial^2 \hat{Y}_{initial}}{\partial X_i^2} &= \alpha_i^2 (1 - \lambda) (\lambda \hat{Y}_{transformed} + 1)^{\frac{1}{\lambda}-2} \end{aligned}$$

Given that $\lambda \hat{Y}_{transformed} + 1 > 0$ and $\lambda = -1.092$, $\frac{\partial^2 \hat{Y}_{initial}}{\partial X_i^2} > 0$. This implies that the relationship between X_i and $\hat{Y}_{initial}$ is convex, and the effect of X_i on $\hat{Y}_{initial}$ is contingent upon the sign of α_i in Table 4. Considering the narrow range of the variables of interest, the impact of X_i on $\hat{Y}_{initial}$ can be approximated as linear within its domain. We perform a reverse transformation of α_i back into original scale as follows:

$$\frac{\partial \hat{Y}_{initial}}{\partial X_i} = (\lambda \alpha_i + 1)^{\frac{1}{\lambda}} - (0 + 1)^{\frac{1}{\lambda}}$$

S.3 Social-cognitive skills and sensory-physical skills

Table S3: Social-cognitive and sensory-physical skills based on Alabdulkareem et al. (2018)

Element ID	Element Name	Description	Category
1.A.1.a.1	Oral Comprehension	The ability to listen to and understand information and ideas presented through spoken words and sentences.	Social-Cognitive skills
1.A.1.a.2	Written Comprehension	The ability to read and understand information and ideas presented in writing.	Social-Cognitive skills
1.A.1.a.3	Oral Expression	The ability to communicate information and ideas in speaking so others will understand.	Social-Cognitive skills
1.A.1.a.4	Written Expression	The ability to communicate information and ideas in writing so others will understand.	Social-Cognitive skills
1.A.1.b.1	Fluency of Ideas	The ability to come up with a number of ideas about a topic (the number of ideas is important, not their quality, correctness, or creativity).	Social-Cognitive skills
1.A.1.b.2	Originality	The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.	Social-Cognitive skills
1.A.1.b.3	Problem Sensitivity	The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing that there is a problem.	Social-Cognitive skills
1.A.1.b.4	Deductive Reasoning	The ability to apply general rules to specific problems to produce answers that make sense.	Social-Cognitive skills
1.A.1.b.5	Inductive Reasoning	The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).	Social-Cognitive skills
1.A.1.b.6	Information Ordering	The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).	Social-Cognitive skills
1.A.1.b.7	Category Flexibility	The ability to generate or use different sets of rules for combining or grouping things in different ways.	Social-Cognitive skills
1.A.1.c.1	Mathematical Reasoning	The ability to choose the right mathematical methods or formulas to solve a problem.	Social-Cognitive skills
1.A.1.c.2	Number Facility	The ability to add, subtract, multiply, or divide quickly and correctly.	Social-Cognitive skills
1.A.1.d.1	Memorization	The ability to remember information such as words, numbers, pictures, and procedures.	Social-Cognitive skills
1.A.1.e.1	Speed of Closure	The ability to quickly make sense of, combine, and organize information into meaningful patterns.	Social-Cognitive skills
1.A.1.e.2	Flexibility of Closure	The ability to identify or detect a known pattern (a figure, object, word, or sound) that is hidden in other distracting material.	Sensory-Physical Skills
1.A.1.e.3	Perceptual Speed	The ability to quickly and accurately compare similarities and differences among sets of letters, numbers, objects, pictures, or patterns. The things to be compared may be presented at the same time or one after the other. This ability also includes comparing a presented object with a remembered object.	Sensory-Physical Skills
1.A.1.f.1	Spatial Orientation	The ability to know your location in relation to the environment or to know where other objects are in	Sensory-Physical Skills

		relation to you.	
1.A.1.f.2	Visualization	The ability to imagine how something will look after it is moved around or when its parts are moved or rearranged.	Sensory-Physical Skills
1.A.1.g.1	Selective Attention	The ability to concentrate on a task over a period of time without being distracted.	Sensory-Physical Skills
1.A.1.g.2	Time Sharing	The ability to shift back and forth between two or more activities or sources of information (such as speech, sounds, touch, or other sources).	Sensory-Physical Skills
1.A.2.a.1	Arm-Hand Steadiness	The ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position.	Sensory-Physical Skills
1.A.2.a.2	Manual Dexterity	The ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects.	Sensory-Physical Skills
1.A.2.a.3	Finger Dexterity	The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.	Sensory-Physical Skills
1.A.2.b.1	Control Precision	The ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions.	Sensory-Physical Skills
1.A.2.b.2	Multilimb Coordination	The ability to coordinate two or more limbs (for example, two arms, two legs, or one leg and one arm) while sitting, standing, or lying down. It does not involve performing the activities while the whole body is in motion.	Sensory-Physical Skills
1.A.2.b.3	Response Orientation	The ability to choose quickly between two or more movements in response to two or more different signals (lights, sounds, pictures). It includes the speed with which the correct response is started with the hand, foot, or other body part.	Sensory-Physical Skills
1.A.2.b.4	Rate Control	The ability to time your movements or the movement of a piece of equipment in anticipation of changes in the speed and/or direction of a moving object or scene.	Sensory-Physical Skills
1.A.2.c.1	Reaction Time	The ability to quickly respond (with the hand, finger, or foot) to a signal (sound, light, picture) when it appears.	Sensory-Physical Skills
1.A.2.c.2	Wrist-Finger Speed	The ability to make fast, simple, repeated movements of the fingers, hands, and wrists.	Sensory-Physical Skills
1.A.2.c.3	Speed of Limb Movement	The ability to quickly move the arms and legs.	Sensory-Physical Skills
1.A.3.a.1	Static Strength	The ability to exert maximum muscle force to lift, push, pull, or carry objects.	Sensory-Physical Skills
1.A.3.a.2	Explosive Strength	The ability to use short bursts of muscle force to propel oneself (as in jumping or sprinting), or to throw an object.	Sensory-Physical Skills
1.A.3.a.3	Dynamic Strength	The ability to exert muscle force repeatedly or continuously over time. This involves muscular endurance and resistance to muscle fatigue.	Sensory-Physical Skills
1.A.3.a.4	Trunk Strength	The ability to use your abdominal and lower back muscles to support part of the body repeatedly or continuously over time without "giving out" or fatiguing.	Sensory-Physical Skills
1.A.3.b.1	Stamina	The ability to exert yourself physically over long periods of time without getting winded or out of breath.	Sensory-Physical Skills

1.A.3.c.1	Extent Flexibility	The ability to bend, stretch, twist, or reach with your body, arms, and/or legs.	Sensory-Physical Skills
1.A.3.c.2	Dynamic Flexibility	The ability to quickly and repeatedly bend, stretch, twist, or reach out with your body, arms, and/or legs.	Sensory-Physical Skills
1.A.3.c.3	Gross Body Coordination	The ability to coordinate the movement of your arms, legs, and torso together when the whole body is in motion.	Sensory-Physical Skills
1.A.3.c.4	Gross Body Equilibrium	The ability to keep or regain your body balance or stay upright when in an unstable position.	Sensory-Physical Skills
1.A.4.a.1	Near Vision	The ability to see details at close range (within a few feet of the observer).	Social-Cognitive skills
1.A.4.a.2	Far Vision	The ability to see details at a distance.	Sensory-Physical Skills
1.A.4.a.3	Visual Color Discrimination	The ability to match or detect differences between colors, including shades of color and brightness.	Sensory-Physical Skills
1.A.4.a.4	Night Vision	The ability to see under low-light conditions.	Sensory-Physical Skills
1.A.4.a.5	Peripheral Vision	The ability to see objects or movement of objects to one's side when the eyes are looking ahead.	Sensory-Physical Skills
1.A.4.a.6	Depth Perception	The ability to judge which of several objects is closer or farther away from you, or to judge the distance between you and an object.	Sensory-Physical Skills
1.A.4.a.7	Glare Sensitivity	The ability to see objects in the presence of a glare or bright lighting.	Sensory-Physical Skills
1.A.4.b.1	Hearing Sensitivity	The ability to detect or tell the differences between sounds that vary in pitch and loudness.	Sensory-Physical Skills
1.A.4.b.2	Auditory Attention	The ability to focus on a single source of sound in the presence of other distracting sounds.	Sensory-Physical Skills
1.A.4.b.3	Sound Localization	The ability to tell the direction from which a sound originated.	Sensory-Physical Skills
1.A.4.b.4	Speech Recognition	The ability to identify and understand the speech of another person.	Social-Cognitive skills
1.A.4.b.5	Speech Clarity	The ability to speak clearly so others can understand you.	Social-Cognitive skills
2.A.1.a	Reading Comprehension	Understanding written sentences and paragraphs in work-related documents.	Social-Cognitive skills
2.A.1.b	Active Listening	Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.	Social-Cognitive skills
2.A.1.c	Writing	Communicating effectively in writing as appropriate for the needs of the audience.	Social-Cognitive skills
2.A.1.d	Speaking	Talking to others to convey information effectively.	Social-Cognitive skills
2.A.1.e	Mathematics	Using mathematics to solve problems.	Social-Cognitive skills
2.A.1.f	Science	Using scientific rules and methods to solve problems.	Social-Cognitive skills
2.A.2.a	Critical Thinking	Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.	Social-Cognitive skills
2.A.2.b	Active Learning	Understanding the implications of new information for both current and future problem-solving and decision-making.	Social-Cognitive skills
2.A.2.c	Learning Strategies	Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.	Social-Cognitive skills
2.A.2.d	Monitoring	Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements	Social-Cognitive skills

		or take corrective action.	
2.B.1.a	Social Perceptiveness	Being aware of others' reactions and understanding why they react as they do.	Social-Cognitive skills
2.B.1.b	Coordination	Adjusting actions in relation to others' actions.	Social-Cognitive skills
2.B.1.c	Persuasion	Persuading others to change their minds or behavior.	Social-Cognitive skills
2.B.1.d	Negotiation	Bringing others together and trying to reconcile differences.	Social-Cognitive skills
2.B.1.e	Instructing	Teaching others how to do something.	Social-Cognitive skills
2.B.1.f	Service Orientation	Actively looking for ways to help people.	Social-Cognitive skills
2.B.2.i	Complex Problem Solving	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.	Social-Cognitive skills
2.B.3.a	Operations Analysis	Analyzing needs and product requirements to create a design.	Social-Cognitive skills
2.B.3.b	Technology Design	Generating or adapting equipment and technology to serve user needs.	Sensory-Physical Skills
2.B.3.c	Equipment Selection	Determining the kind of tools and equipment needed to do a job.	Sensory-Physical Skills
2.B.3.d	Installation	Installing equipment, machines, wiring, or programs to meet specifications.	Sensory-Physical Skills
2.B.3.e	Programming	Writing computer programs for various purposes.	Social-Cognitive skills
2.B.3.g	Operations Monitoring	Watching gauges, dials, or other indicators to make sure a machine is working properly.	Sensory-Physical Skills
2.B.3.h	Operation and Control	Controlling operations of equipment or systems.	Sensory-Physical Skills
2.B.3.j	Equipment Maintenance	Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.	Sensory-Physical Skills
2.B.3.k	Troubleshooting	Determining causes of operating errors and deciding what to do about it.	Sensory-Physical Skills
2.B.3.l	Repairing	Repairing machines or systems using the needed tools.	Sensory-Physical Skills
2.B.3.m	Quality Control Analysis	Conducting tests and inspections of products, services, or processes to evaluate quality or performance.	Sensory-Physical Skills
2.B.4.e	Judgment and Decision Making	Considering the relative costs and benefits of potential actions to choose the most appropriate one.	Social-Cognitive skills
2.B.4.g	Systems Analysis	Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.	Social-Cognitive skills
2.B.4.h	Systems Evaluation	Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.	Social-Cognitive skills
2.B.5.a	Time Management	Managing one's own time and the time of others.	Social-Cognitive skills
2.B.5.b	Management of Financial Resources	Determining how money will be spent to get the work done, and accounting for these expenditures.	Social-Cognitive skills
2.B.5.c	Management of Material Resources	Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work.	Social-Cognitive skills
2.B.5.d	Management of Personnel Resources	Motivating, developing, and directing people as they work, identifying the best people for the job.	Social-Cognitive skills
2.C.1.a	Administration and Management	Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique,	Social-Cognitive skills

		production methods, and coordination of people and resources.	
2.C.1.c	Economics and Accounting	Knowledge of economic and accounting principles and practices, the financial markets, banking, and the analysis and reporting of financial data.	Social-Cognitive skills
2.C.1.d	Sales and Marketing	Knowledge of principles and methods for showing, promoting, and selling products or services. This includes marketing strategy and tactics, product demonstration, sales techniques, and sales control systems.	Social-Cognitive skills
2.C.1.e	Customer and Personal Service	Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.	Social-Cognitive skills
2.C.1.f	Personnel and Human Resources	Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.	Social-Cognitive skills
2.C.2.a	Production and Processing	Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.	Sensory-Physical Skills
2.C.2.b	Food Production	Knowledge of techniques and equipment for planting, growing, and harvesting food products (both plant and animal) for consumption, including storage/handling techniques.	Sensory-Physical Skills
2.C.3	Engineering and Technology	Knowledge of the design, development, and application of technology for specific purposes.	Sensory-Physical Skills
2.C.3.b	Engineering and Technology	Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.	Sensory-Physical Skills
2.C.3.a	Computers and Electronics	Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.	Social-Cognitive skills
2.C.3.c	Design	Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.	Sensory-Physical Skills
2.C.3.d	Building and Construction	Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.	Sensory-Physical Skills
2.C.3.e	Mechanical	Knowledge of machines and tools, including their designs, uses, repair, and maintenance.	Sensory-Physical Skills
2.C.4.a	Mathematics Knowledge	Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.	Social-Cognitive skills
2.C.4.b	Physics	Knowledge and prediction of physical principles, laws, their interrelationships, and applications to understanding fluid, material, and atmospheric dynamics, and mechanical, electrical, atomic and sub-atomic structures and processes.	Sensory-Physical Skills
2.C.4.c	Chemistry	Knowledge of the chemical composition, structure, and properties of substances and of the chemical processes and transformations that they undergo. This includes uses of chemicals and their	Sensory-Physical Skills

		interactions, danger signs, production techniques, and disposal methods.	
2.C.4.d	Biology	Knowledge of plant and animal organisms, their tissues, cells, functions, interdependencies, and interactions with each other and the environment.	Social-Cognitive skills
2.C.4.e	Psychology	Knowledge of human behavior and performance; individual differences in ability, personality, and interests; learning and motivation; psychological research methods; and the assessment and treatment of behavioral and affective disorders.	Social-Cognitive skills
2.C.4.f	Sociology and Anthropology	Knowledge of group behavior and dynamics, societal trends and influences, human migrations, ethnicity, cultures, and their history and origins.	Social-Cognitive skills
2.C.4.g	Geography	Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.	Social-Cognitive skills
2.C.5.a	Medicine and Dentistry	Knowledge of the information and techniques needed to diagnose and treat human injuries, diseases, and deformities. This includes symptoms, treatment alternatives, drug properties and interactions, and preventive health-care measures.	Social-Cognitive skills
2.C.5.b	Therapy and Counseling	Knowledge of principles, methods, and procedures for diagnosis, treatment, and rehabilitation of physical and mental dysfunctions, and for career counseling and guidance.	Social-Cognitive skills
2.C.6	Education and Training	Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.	Social-Cognitive skills
2.C.7.a	English Language	Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	Social-Cognitive skills
2.C.7.b	Foreign Language	Knowledge of the structure and content of a foreign (non-English) language including the meaning and spelling of words, rules of composition and grammar, and pronunciation.	Social-Cognitive skills
2.C.7.c	Fine Arts	Knowledge of the theory and techniques required to compose, produce, and perform works of music, dance, visual arts, drama, and sculpture.	Social-Cognitive skills
2.C.7.d	History and Archeology	Knowledge of historical events and their causes, indicators, and effects on civilizations and cultures.	Social-Cognitive skills
2.C.7.e	Philosophy and Theology	Knowledge of different philosophical systems and religions. This includes their basic principles, values, ethics, ways of thinking, customs, practices, and their impact on human culture.	Social-Cognitive skills
2.C.8.a	Public Safety and Security	Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions.	Sensory-Physical Skills
2.C.8.b	Law and Government	Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.	Social-Cognitive skills
2.C.9.a	Telecommunications	Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications	Social-Cognitive skills

		systems.	
2.C.9.b	Communications and Media	Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.	Social-Cognitive skills
2.C.10	Transportation	Knowledge of principles and methods for moving people or goods by air, rail, sea, or road, including the relative costs and benefits.	Sensory-Physical Skills
4.A.1.a.1	Getting Information	Observing, receiving, and otherwise obtaining information from all relevant sources.	Social-Cognitive skills
4.A.1.a.2	Monitoring Processes, Materials, or Surroundings	Monitoring and reviewing information from materials, events, or the environment, to detect or assess problems.	Sensory-Physical Skills
4.A.1.b.1	Identifying Objects, Actions, and Events	Identifying information by categorizing, estimating, recognizing differences or similarities, and detecting changes in circumstances or events.	Social-Cognitive skills
4.A.1.b.2	Inspecting Equipment, Structures, or Materials	Inspecting equipment, structures, or materials to identify the cause of errors or other problems or defects.	Sensory-Physical Skills
4.A.1.b.3	Estimating the Quantifiable Characteristics of Products, Events, or Information	Estimating sizes, distances, and quantities; or determining time, costs, resources, or materials needed to perform a work activity.	Sensory-Physical Skills
4.A.2.a.1	Judging the Qualities of Objects, Services, or People	Assessing the value, importance, or quality of things or people.	Social-Cognitive skills
4.A.2.a.2	Processing Information	Compiling, coding, categorizing, calculating, tabulating, auditing, or verifying information or data.	Social-Cognitive skills
4.A.2.a.3	Evaluating Information to Determine Compliance with Standards	Using relevant information and individual judgment to determine whether events or processes comply with laws, regulations, or standards.	Social-Cognitive skills
4.A.2.a.4	Analyzing Data or Information	Identifying the underlying principles, reasons, or facts of information by breaking down information or data into separate parts.	Social-Cognitive skills
4.A.2.b.1	Making Decisions and Solving Problems	Analyzing information and evaluating results to choose the best solution and solve problems.	Social-Cognitive skills
4.A.2.b.2	Thinking Creatively	Developing, designing, or creating new applications, ideas, relationships, systems, or products, including artistic contributions.	Social-Cognitive skills
4.A.2.b.3	Updating and Using Relevant Knowledge	Keeping up-to-date technically and applying new knowledge to your job.	Social-Cognitive skills
4.A.2.b.4	Developing Objectives and Strategies	Establishing long-range objectives and specifying the strategies and actions to achieve them.	Social-Cognitive skills
4.A.2.b.5	Scheduling Work and Activities	Scheduling events, programs, and activities, as well as the work of others.	Social-Cognitive skills
4.A.2.b.6	Organizing, Planning, and Prioritizing Work	Developing specific goals and plans to prioritize, organize, and accomplish your work.	Social-Cognitive skills
4.A.3.a.1	Performing General Physical Activities	Performing physical activities that require considerable use of your arms and legs and moving your whole body, such as climbing, lifting, balancing, walking, stooping, and handling materials.	Sensory-Physical Skills
4.A.3.a.2	Handling and Moving Objects	Using hands and arms in handling, installing, positioning, and moving materials, and manipulating things.	Sensory-Physical Skills

4.A.3.a.3	Controlling Machines and Processes	Using either control mechanisms or direct physical activity to operate machines or processes (not including computers or vehicles).	Sensory-Physical Skills
4.A.3.a.4	Operating Vehicles, Mechanized Devices, or Equipment	Running, maneuvering, navigating, or driving vehicles or mechanized equipment, such as forklifts, passenger vehicles, aircraft, or watercraft.	Sensory-Physical Skills
4.A.3.b.1	Working with Computers	Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.	Social-Cognitive skills
4.A.3.b.2	Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment	Providing documentation, detailed instructions, drawings, or specifications to tell others about how devices, parts, equipment, or structures are to be fabricated, constructed, assembled, modified, maintained, or used.	Sensory-Physical Skills
4.A.3.b.4	Repairing and Maintaining Mechanical Equipment	Servicing, repairing, adjusting, and testing machines, devices, moving parts, and equipment that operate primarily on the basis of mechanical (not electronic) principles.	Sensory-Physical Skills
4.A.3.b.5	Repairing and Maintaining Electronic Equipment	Servicing, repairing, calibrating, regulating, fine-tuning, or testing machines, devices, and equipment that operate primarily on the basis of electrical or electronic (not mechanical) principles.	Sensory-Physical Skills
4.A.3.b.6	Documenting/Recording Information	Entering, transcribing, recording, storing, or maintaining information in written or electronic/magnetic form.	Social-Cognitive skills
4.A.4.a.1	Interpreting the Meaning of Information for Others	Translating or explaining what information means and how it can be used.	Social-Cognitive skills
4.A.4.a.2	Communicating with Supervisors, Peers, or Subordinates	Providing information to supervisors, co-workers, and subordinates by telephone, in written form, e-mail, or in person.	Social-Cognitive skills
4.A.4.a.3	Communicating with People Outside the Organization	Communicating with people outside the organization, representing the organization to customers, the public, government, and other external sources. This information can be exchanged in person, in writing, or by telephone or e-mail.	Social-Cognitive skills
4.A.4.a.4	Establishing and Maintaining Interpersonal Relationships	Developing constructive and cooperative working relationships with others, and maintaining them over time.	Social-Cognitive skills
4.A.4.a.5	Assisting and Caring for Others	Providing personal assistance, medical attention, emotional support, or other personal care to others such as coworkers, customers, or patients.	Social-Cognitive skills
4.A.4.a.6	Selling or Influencing Others	Convincing others to buy merchandise/goods or to otherwise change their minds or actions.	Social-Cognitive skills
4.A.4.a.7	Resolving Conflicts and Negotiating with Others	Handling complaints, settling disputes, and resolving grievances and conflicts, or otherwise negotiating with others.	Social-Cognitive skills
4.A.4.a.8	Performing for or Working Directly with the Public	Performing for people or dealing directly with the public. This includes serving customers in restaurants and stores, and receiving clients or guests.	Social-Cognitive skills
4.A.4.b.1	Coordinating the Work and Activities of Others	Getting members of a group to work together to accomplish tasks.	Social-Cognitive skills
4.A.4.b.2	Developing and Building Teams	Encouraging and building mutual trust, respect, and cooperation among team members.	Social-Cognitive skills
4.A.4.b.3	Training and Teaching Others	Identifying the educational needs of others, developing formal educational or training programs	Social-Cognitive skills

		or classes, and teaching or instructing others.	
4.A.4.b.4	Guiding, Directing, and Motivating Subordinates	Providing guidance and direction to subordinates, including setting performance standards and monitoring performance.	Social-Cognitive skills
4.A.4.b.5	Coaching and Developing Others	Identifying the developmental needs of others and coaching, mentoring, or otherwise helping others to improve their knowledge or skills.	Social-Cognitive skills
4.A.4.b.6	Providing Consultation and Advice to Others	Providing guidance and expert advice to management or other groups on technical, systems-, or process-related topics.	Social-Cognitive skills
4.A.4.c.1	Performing Administrative Activities	Performing day-to-day administrative tasks such as maintaining information files and processing paperwork.	Social-Cognitive skills
4.A.4.c.2	Staffing Organizational Units	Recruiting, interviewing, selecting, hiring, and promoting employees in an organization.	Social-Cognitive skills
4.A.4.c.3	Monitoring and Controlling Resources	Monitoring and controlling resources and overseeing the spending of money.	Social-Cognitive skills
2.C.1.b	Clerical	Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.	Social-Cognitive skills

S.4 Cognitive abilities, psychomotor abilities, physical abilities, and sensory abilities

Table S4: Social-cognitive and sensory-physical skills based on the O*NET content model

Element ID	Element Name	Subcategory	Category
1.A.2.a.1	Arm-Hand Steadiness	Psychomotor Abilities	Sensory-Physical Skills
1.A.4.b.2	Auditory Attention	Sensory Abilities	Sensory-Physical Skills
1.A.1.b.7	Category Flexibility	Cognitive Abilities	Social-Cognitive skills
1.A.2.b.1	Control Precision	Psychomotor Abilities	Sensory-Physical Skills
1.A.1.b.4	Deductive Reasoning	Cognitive Abilities	Social-Cognitive skills
1.A.4.a.6	Depth Perception	Sensory Abilities	Sensory-Physical Skills
1.A.3.c.2	Dynamic Flexibility	Physical Abilities	Sensory-Physical Skills
1.A.3.a.3	Dynamic Strength	Physical Abilities	Sensory-Physical Skills
1.A.3.a.2	Explosive Strength	Physical Abilities	Sensory-Physical Skills
1.A.3.c.1	Extent Flexibility	Physical Abilities	Sensory-Physical Skills
1.A.4.a.2	Far Vision	Sensory Abilities	Sensory-Physical Skills
1.A.2.a.3	Finger Dexterity	Psychomotor Abilities	Sensory-Physical Skills
1.A.1.e.2	Flexibility of Closure	Cognitive Abilities	Social-Cognitive skills
1.A.1.b.1	Fluency of Ideas	Cognitive Abilities	Social-Cognitive skills
1.A.4.a.7	Glare Sensitivity	Sensory Abilities	Sensory-Physical Skills
1.A.3.c.3	Gross Body Coordination	Physical Abilities	Sensory-Physical Skills
1.A.3.c.4	Gross Body Equilibrium	Physical Abilities	Sensory-Physical Skills
1.A.4.b.1	Hearing Sensitivity	Sensory Abilities	Sensory-Physical Skills
1.A.1.b.5	Inductive Reasoning	Cognitive Abilities	Social-Cognitive skills
1.A.1.b.6	Information Ordering	Cognitive Abilities	Social-Cognitive skills
1.A.2.a.2	Manual Dexterity	Psychomotor Abilities	Sensory-Physical Skills
1.A.1.c.1	Mathematical Reasoning	Cognitive Abilities	Social-Cognitive skills
1.A.1.d.1	Memorization	Cognitive Abilities	Social-Cognitive skills
1.A.2.b.2	Multilimb Coordination	Psychomotor Abilities	Sensory-Physical Skills
1.A.4.a.1	Near Vision	Sensory Abilities	Sensory-Physical Skills
1.A.4.a.4	Night Vision	Sensory Abilities	Sensory-Physical Skills
1.A.1.c.2	Number Facility	Cognitive Abilities	Social-Cognitive skills
1.A.1.a.1	Oral Comprehension	Cognitive Abilities	Social-Cognitive skills
1.A.1.a.3	Oral Expression	Cognitive Abilities	Social-Cognitive skills
1.A.1.b.2	Originality	Cognitive Abilities	Social-Cognitive skills
1.A.1.e.3	Perceptual Speed	Cognitive Abilities	Social-Cognitive skills
1.A.4.a.5	Peripheral Vision	Sensory Abilities	Sensory-Physical Skills
1.A.1.b.3	Problem Sensitivity	Cognitive Abilities	Social-Cognitive skills
1.A.2.b.4	Rate Control	Psychomotor Abilities	Sensory-Physical Skills
1.A.2.c.1	Reaction Time	Psychomotor Abilities	Sensory-Physical Skills
1.A.2.b.3	Response Orientation	Psychomotor Abilities	Sensory-Physical Skills
1.A.1.g.1	Selective Attention	Cognitive Abilities	Social-Cognitive skills
1.A.4.b.3	Sound Localization	Sensory Abilities	Sensory-Physical Skills
1.A.1.f.1	Spatial Orientation	Cognitive Abilities	Social-Cognitive skills
1.A.4.b.5	Speech Clarity	Sensory Abilities	Sensory-Physical Skills
1.A.4.b.4	Speech Recognition	Sensory Abilities	Sensory-Physical Skills

1.A.1.e.1	Speed of Closure	Cognitive Abilities	Social-Cognitive skills
1.A.2.c.3	Speed of Limb Movement	Psychomotor Abilities	Sensory-Physical Skills
1.A.3.b.1	Stamina	Physical Abilities	Sensory-Physical Skills
1.A.3.a.1	Static Strength	Physical Abilities	Sensory-Physical Skills
1.A.1.g.2	Time Sharing	Cognitive Abilities	Social-Cognitive skills
1.A.3.a.4	Trunk Strength	Physical Abilities	Sensory-Physical Skills
1.A.4.a.3	Visual Color Discrimination	Sensory Abilities	Sensory-Physical Skills
1.A.1.f.2	Visualization	Cognitive Abilities	Social-Cognitive skills
1.A.2.c.2	Wrist-Finger Speed	Psychomotor Abilities	Sensory-Physical Skills
1.A.1.a.2	Written Comprehension	Cognitive Abilities	Social-Cognitive skills
1.A.1.a.4	Written Expression	Cognitive Abilities	Social-Cognitive skills