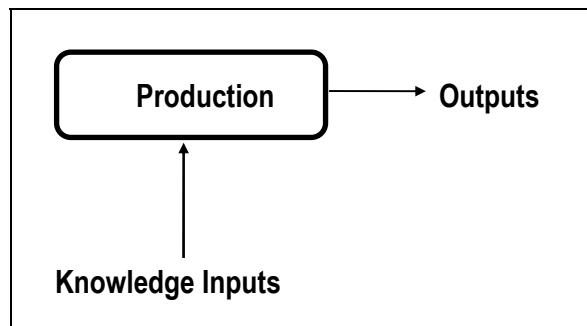


THE MATRIX TAXONOMY FOR INDUSTRIAL CLASSIFICATION SYSTEMS



In their day to day life, human beings are involved in a wide range of activities to produce the necessities of life. The process of production, in a very simple procedure, can be perceived as a system with "inputs" and "outputs", although this method is not able to present all the intricate aspects of the process of production. In the other reports of this series, production has been depicted in a back box with knowledge as one of its inputs.

Human production activities are so diverse that correct classifications are always required to organize them properly. However, there exist a few “standard sectoral industrial” classifications, mainly based on sorting the production activities and relating them to the end products, or outputs.

Standard International Trade Classification - SITC, is an internationally accepted industrial classification mainly for customs duties and export/import studies. SITC consists of the following main groups:

- Food and live animal.
- Beverage and tobacco
- Crude materials, inedible except fuel
- Mineral fuels, lubricants and related materials
- Animal and vegetable oils, fats and waxes
- Chemical and related products
- Manufactured goods classified chiefly by materials
- Machinery and transport equipment
- Miscellaneous manufactured articles
- Commodities and transactions not classified elsewhere SITC

The International Standard Industrial Classification of all Economic Activities - ISIC is another internationally accepted standard classification for economic studies, which has major groupings as follows:

- Agriculture, hunting, forestry and fishing
- Mining and quarrying
- Manufacturing

- Electricity, gas and water
- Construction
- Wholesale, and retail trade and restaurant and hotels
- Transport, storage and communication
- Financing, insurance, real estate and business services
- Community, social and personal services
- Activities not adequately defined

In Canada, as well as in the US, the Standard Industrial Classification - SIC is the dominant sectoral classification. SIC classification consists of the following main groups (sectors):

- Agriculture
- Fishing
- Forestry
- Mining
- Manufacturing
- Construction
- Transportation
- Communication/Utility
- Wholesale Trade
- Retail Trade
- Finance/Insurance
- Real Estate
- Business Services
- Government Services

The SIC classification, the same as the other sectoral classifications which are based on assorting the outputs of a production, may be depicted in a table as follows:

Agriculture	Fishing	Forestry	Mining	Manufacturing	Construction	Transportation	Communication/Utility	Wholesale Trade	Retail Trade	Finance/Insurance	Real Estate	Business Services	Government Services
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The stage or level of innovation is another criteria to organizing the businesses. Innovation can appear in **all sectors of activity**, whether traditional, or high-tech¹. Innovation classification is based on the knowledge input of a production and should be depicted independent from sectoral classification. A matrix configuration is probably the best procedure to depict the relationships between the sectoral and innovation classifications.

Innovation, according to the Holistic model, is organized into four main stages, which is not limited to any sector of production activity:

Production (May be organized according to SIC)
Design and Development - D&D
Industrial Research and Development - R&D

Basic Research - BR

A matrix configuration links the two classifications: conventional sectoral (organized according to the main products - outputs) and innovation process (organized according to knowledge input):

Agriculture	Fishing	Forestry	Mining	Manufacturing	Construction	Transportation	Communication/Utility	Wholesale Trade	Retail Trade	Finance/Insurance	Real Estate	Business Services	Government Services
D&D	D&D	D&D	D&D	D&D	D&D	D&D	D&D	D&D	D&D	D&D	D&D	D&D	D&D
R&D	R&D	R&D	R&D	R&D	R&D	R&D	R&D	R&D	R&D	R&D	R&D	R&D	R&D
BR	BR	BR	BR	BR	BR	BR	BR	BR	BR	BR	BR	BR	BR

WHERE TO GO FROM HERE

Knowledge-based economy, knowledge-based industry, information industry, information society, information era, high tech, Some documents have used them as almost interchangeable terms. Are they the same or synonymous? If not, how they are connected to each other? **The Matrix Taxonomy for Industrial Classification Systems** is able to assist us to clarify some distinctions between them.

Information Technology: In the context of industrial classifications, “information technology” consists mainly of the computation and communication industries. In the SIC, for instance, the “information technology” belongs to “Communication and Utility” sector. Information technology will continue to have wider impacts in many aspects of our life and every one should become familiar with the applications of the information technology. However, one should not infer that in future every one will become a computer programmer and every business will deal with computer production. Obviously there are strong interactions between all industries and economic sectors. For instance, information technology has applications in agriculture and vice versa.

Information era, information society, and even knowledge society are arbitrary titles for the current period. In a similar way, the 1950s was named "nuclear age" and the 1960s "space age".

Knowledge-based industries is another arbitrary classification to distinguish a specific set of industries which are believed to be R&D-oriented. Computation, communication, aviation and biotechnology are well known knowledge-based or R&D-oriented industries.

One should bear in mind that R&D is one of the procedures for innovation. Innovation is not monopolized by any specific group of businesses or sector of industry. Innovation is a process, not an activity or output, and is applied to any industry. As the matrix taxonomy for industrial classifications indicates, it is not true that only one set of industries deserves or initiates innovation, or is going to grow.

The classification of knowledge-based industry may be useful for financial institutions and banks to organize the businesses with which they deal; such as software development, computer parts, genetic engineering and so on. However, using this classification to give the impression that other industries

have no knowledge base or to develop policies for subsidizing one group of industries rather than another will not assist our society to develop a better understanding of the new economy.

Knowledge Economy: Knowledge has always been integrated with the life-ways and endeavors of the human race from the very beginning. Without knowledge the human being could not develop, or even sustain life on Earth. However, there are indications that over time, knowledge has exerted an increasing impact on our lives.

Economics, the social science concerned with the study of production, distribution and consumption of wealth, has evolved around the classification of factors of production into land, labor and capital. In this context it is very difficult to articulate a position for knowledge.

In recent decades efforts have been made to integrate knowledge as an independent factor of production in economic studies and models. Knowledge economy is often used to distinguish a set of new macro-economic schools. The utilization of this terminology, however, should not imply that other economies were knowledge-less. There is a possibility that integration of knowledge in the very basic economic model will have consequences beyond the domain of economics.

Industrial Classification based on the R&D Intensity

Based on the ‘R&D expenditures as the percentage of production’ the OECD categorizes industry into “high”, “medium”, and “low”. The following table² provides further information in this respect:

1972-74		1979-81		1987-89	*
High		High		High	
Aerospace	19.6	Aerospace	14.2	Aerospace	
Computer	10.4	Computer	9.0	Computer	
Electronics	7.1	Pharmaceuticals	7.5	Electronics	
Pharmaceuticals	6.1	Electronics	7.4	Pharmaceuticals	
Instruments	3.9	Instruments	4.9		
Electrical Machinery	3.3	Electrical Machinery	3.2		
Medium		Medium		Medium-High	
Motor Vehicles	2.4	Motor Vehicles	2.7	Instruments	
Chemicals	2.2	Chemicals	2.1	Motor Vehicles	
Rubber & Plastics	1.2	Machinery Nec.	1.4	Chemicals	
Machinery Nec.	1.1	Rubber & Plastics	1.1	Electrical Machinery	
Other Manufacturing	0.9	Other Manufacturing	1.0		
Petroleum Refining	0.8				
Low		Low		Medium Low	
Ship Building	0.6	Other Transport	0.7	Machinery Nec.	
Stone, Clay & Glass	0.6	Stone, Clay & Glass	0.6	Other Transport	
Non-Ferrous Metals	0.5	Petroleum Refining	0.6	Ship Building	

* Information about this column is not available in the copy that I have access.

Other Transport	0.5	Shipbuilding	0.6	Petroleum Refinery
Ferrous Metals	0.4	Non-Ferrous Metals	0.6	Stone, Clay & Glass
Fabricated Metals	0.3	Ferrous Metals	0.5	Other Manufacturing
Paper & Printing	0.2	Fabricated Metals	0.5	Rubber & Plastics
Food, Drink & Tobacco	0.2	Paper & Printing	0.2	Non-Ferrous Metals
Textile & Clothing	0.1	Food, Drink & Tobacco	0.2	
Wood & Furniture	0.1	Textile & Clothing	0.1	Low
		Wood & Furniture	0.1	Ferrous Metals
				Fabricated Metals
				Food, Drink & Tobacco
				Paper & Printing
				Textiles & Clothing
				Wood & Furniture

It appears the classification of industries into ‘high-tech’, ‘mid-tech’ and ‘low-tech’ relates to the ‘Industrial Classification Based on R&D Intensity’. On the other hand, the R&D classification is based on the Linear model of innovation. The development and application of non-linear models of innovation, consequently, may effect the classification of the industrial classifications, as well.

In addition to the above, there exist many other classifications of industries, for instance the following list:

Emerging Industries: Space, medical technology, software engineering, advanced material, and biotechnology

Hi-Technologies: Telecommunications, computer and software, aviation, pharmaceutical and microelectronics

Established Technologies: Energy, electrical products, printing, food, clothing, engineering consulting and financial services

Resource-based Technologies: Mining, forestry, fishing and agriculture

REFERENCE

¹ European Commission, 1996, **Green Paper on Innovation**, EC, Luxembourg.

² OECD, 1992, Annual Review of Industrial Policy, OECD, Paris

¹ Last update:, October 23, 1998