Simulation The First - 50 Years

The Simulation Industry in Search of Recognition by Vince Amico and Lorraine Amico

INTRODUCTION

Simulation is reported to be a multibillion-dollar industry that employs thousands of scientists, engineers, and technicians. Professionals in the simulation business, after pioneering and promoting the field for more than half a century, certainly recognize the increasingly important and diverse role that simulation plays in our modern lives. Labor markets impacted by substantial expenditures for simulation products and services, including, for example, the greater Orlando area in Florida, certainly understand the importance of modeling and simulation to all economic sectors.

Despite the bold claims of economic significance, simulation companies and professionals in the workforce may be totally invisible to those who are not intimately knowledgeable about simulation goods and services. In 1997, it was first observed that modeling and simulation technically was not classified as an industry in government reports used by policy makers. (Ref 1) Nor can information on the simulator business be found in career development materials available to students and job seekers.

Over the past three years, a dialog bas ensued concerning the recognition of simulation in the economy. A number of leaders in the field believe that this recognition is crucial to further advance the simulation profession and more closely align the diverse simulator application domains. Of particular concern is the availability of data needed to determine the number of employees who are potential candidates for the Modeling and Simulation Professional Certification Program. (Ref 2)

Most recently the dialog has gained momentum through the efforts of Dr. John Hitt, President of the University of Central Florida (UCF), who has corresponded with Elaine Chao, the U.S. Secretary of Labor. The academic community, including UCF, has begun to offer advanced multidiscipline degree programs to prepare future workers with simulation-specific skills. From this perspective, information is needed on the number and types of businesses conducting simulation work; the goods and services that are designed, developed, and produced; and the number and characteristics of employed simulation professionals.

The objective of this article is to give some insight into how and where simulation fits into the industrial and occupational structures of the U.S. economy. Based on the findings, several issues are raised to focus the discussion of how to increase the recognition of simulation. The SCS, in conjunction with other modeling and simulation organizations, should take several steps to support future industry growth, the development of a skilled simulation workforce, and a strengthened image of modeling and simulation in our economy.

THE STRUCTURE OF THE U.S. ECONOMY

Currently, over 9.3 million business establishments employ 132.2 million workers in the U.S. economy. Businesses are classified into 1170 detailed industries by the North American Industry Classification System (NAICS). The Standard Occupational Classification (SOC) groups job s into over 820 occupations.

Business establishments are continually transforming the workplace and the labor force to meet the demands of the global economy. The NAICS and SOC, by necessity, are dynamic also. The federal government is making a concerted effort to update these classification structures to reflect the evolution of workforce skills and business processes and products.

In 2005 the industrial and occupational classification systems will be revised to assure that data are useful for analyzing the current structure of the economy and projected trends.

INDUSTRIAL CLASSIFICATION IS HIERARCHICAL

U.S. business establishments are divided into 20 industry sectors by the NAICS. Five sectors in NAICS are largely manufacturing industries and fifteen are entirely service industries. Industries within each sector are grouped according to product ion criteria. (Ref 3) In the design of the NAICS, attention was given to developing production-oriented classifications for new and emerging industries; service industries in general; and industries engaged in the production of advanced technologies.

Within manufacturing, the sub-sectors generally reflect distinct production processes related to material inputs, production equipment and employee skills. Businesses that share basic processes and use closely similar technology to produce similar goods/services a regrouped in the same industry. For example, Electronic Equipment, Appliances & Component Manufacturing is a new NAICS code. It brings together industries producing computers, communications equipment, and semiconductors because there are inherent technological similarities among their production processes and it is likely that these technologies will continue to converge in the future. The production distinctions become more narrowly defined as the industries become more detailed.

Businesses in the Services Sectors sell the expertise, knowledge and skills of their employees. Most of these industries have production processes that are almost wholly dependent on worker skills rather than on equipment and materials. Individual industries are defined on the basis of the particular expertise and training of the service provider. For example, offices of engineering services are grouped into a single industry.

WHERE ARE *SIMULATION* BUSINESSES FOUND?

Since the late ‘90s, it has been generally accepted that no single "simulation industry" can be found in the NAICS or in its predecessor, the Standard Industrial Classification (SIC) System. To identify where simulation businesses are located in the NAICS, the NCS and the NTSA conducted limited membership surveys in 2001. (Ref 4) In the surveys, businesses were asked to indicate what industry code(s) they use to report their activities to the government. Companies were encouraged to report multiple NAICS codes to describe their workplace. Twenty businesses that are thought to be fairly representative of the full membership of each association responded to the surveys. In 2001, the survey results were reported and recommendations presented to the membership of the organizations. (Ref 5)

The survey results show that business respondents report their simulation activity under 20 different NAICS codes. Only 6 codes had a significant number of respondents. These six codes are divided between manufacturing and service industries. Of the NCS/NTSA survey respondents, the largest number (65%) reported employment in the Industrial and Commercial Machine and Equipment Manufacturing Industry and the second largest number (53%) reported employment in Computer Systems Design and Related Services Industry. The identified codes could be considered to represent the industry groups where a major portion of simulation activity is taking place. Table 1 shows available information on employment, payroll, establishment, and shipment/receipt value in simulation-related industries.

It shows that the simulator-related-industry codes, as identified in the NCS/NTSA surveys, accounted for:

- Roughly 8.7 million employees out of the total 132.2 million U.S. employees in 2001, or about 12.6%.
- Of this, 3.6 million or 2.7% are employed in manufacturing and 5.1 million or 9.9% in services industries.
- Approximately 8.0% of the total 9.3 million business establishments in 1997. Of that, less than 1.0% was in manufacturing and 7.4% was in service establishments.
- Of the 10 industries identified, five including the one manufacturing code that actually references electronic teaching machines and flight simulators, SIC 3699, have employment levels too small to disclose.
- Over $367.7 million worth of goods and services. Manufactured goods shipped were valued at $102 million and services receipts were valued at $265 million.
- An estimated payroll of $115.6 million with $15.6 from manufacturing and $100.0 from services industries.
- The actual numbers for simulator-specific activity in each area above is a subset of these figures because establishments in the related codes may conduct non simulation activities as well.

Clearly simulation is a complex economic activity that has a presence in both the manufacturing and service sectors. According to all indicators, simulation activity appears to be greater in the services sector when employment, number of establishments, value of goods and services and payroll figures are compared. It should be noted that service industries are expected to account for a large share of the fastest-growing industries. So, services industries that are simulation specific should be expected to follow that trend.

FOUR OCCUPATIONAL LEVELS DESCRIBE JOBS

The SOC system classifies jobs where work is performed for pay or profit. (Ref 6) Within the four occupational levels, occupations are combined into 23 major groups, 96 minor groups, and 449 broad occupations. At each of the levels, occupations requiring similar job duties, skills, and education or experience are grouped together.

Occupational code revisions for the SOC are done every five years under the auspices of the U.S. Office of Management and Budget. It is anticipated that the next major SOC revision will begin in 2005. The occupational titles developed by the Department of Labor that replace the Dictionary of Occupational Titles are updated annually.

Note: NEC: Not Elsewhere Classified

Table 1

SIC	Industry	#Emps.	#Locales	Shipment /Receipt Value	Annual Payroll
	Total Nonfarming	132,213			
	Total Manufacturing Sector	17,698			
35	Industrial Machinery & Equipment	2,013	56,383	407,393	74,550
355	Special Industry Machinery	156	4,781	D	D
3559	Special Industry Machinery (NEC)	D	2,467	D	D
357	Computer & Office Equipment	355	2,018	108,867	11,099
3571	Electronic Computers	203	563	66,331	4,282
358	Refrigeration & Service Machinery	198	2,277	39,317	6,800
3589	Service Industry Machinery	D	1,165	7,596	1,460
3599	Industrial, Commercial Machine, Equip. (NEC)	299	24,637	28,968	10,032
36	Electrical & Electronic Equipment	1,612	17,104	348,559	58,256
369	Equipment & Supplies	130	1,701	D	D
3699	Electrical Equipment & Supplies (NEC)	D	691	D	D
	Services Sector	41,024			
73	Business Services	9,628	397,264	528,515	211,484
737	Computer/Data Processing Services	2, 193	103,278	224,114	75,805
7371	Computer Programming Services	538	31,624	38,300	18,417
7373	Computer Integrated System Design	235	10,571	35,270	11,341
7379	Computer Related Services (NEC)	D	28,762	21,541	9,313
738	Misc. Business Services	1,825	94,653	88,561	30,008
7389	Business Services (NEC)	D	69,376	62,276	17,597
87	Engineering & Management Services	3,525	292,162	302,005	121,659
871	Engineering & Architectural Services	1,060	82,153	108,622	43,518

WHERE DO SIMULATOR PROFESSIONALS FIT?

NCS/NTSA survey respondents identified all the relevant occupation codes they used to classify their workforce on government data collection instruments. The survey results indicate 18 different occupational codes are used. Of the 18 codes, 12 had a significant number of respondents. The largest number of responses was reported in three closely related computer occupations. The largest number of businesses reported using the Computer Software Engineers Applications Occupation (94%), Computer Programmer Occupation (82%), and Computer Systems Analyst Occupation (71%) to describe their workforce. The next occupation used was Electrical and Electronics Engineers reported by 65% of the businesses.

The 12 codes fall into four major occupational groups that include managers; computer occupations and mathematicians; architects and engineers; and life, physical, and social science occupations. These codes could be considered to represent the occupations where a majority of simulation professionals work. In reviewing the occupational codes used, it is interesting to note that there is no occupational title that contains the word, "simulation;" although simulation is referred to in some definitions.

Table 2, that lists the simulation-related professions identified by the NCS/NTSA survey results, shows that:

- The occupations where simulation professionals work make up about 2.2% of total employment.
- There were roughly 3.1 million employees in the detailed NCS/NTSA identified occupations. The actual employment number for simulator workers is a subset of this because all workers in these codes do not have simulator-related job descriptions.
- The life physical, and social science group is among the smallest occupational groups in terms of employment.
- The identified occupations, except mathematicians, should see favorable job growth over the next ten years.
- Eight of the 10 fastest growing occupations are computer-related, commonly referred to as information technology occupations.

Table 2

Occupation	#Employed 2000*	%Total	Outlook to 2010
Total, all occupations 770	129,739.0	100.0	
Management Occupations 30	7,782.7	6.0	
- Computer/Info System Mgr.	313.0	0.2	Grow much faster than avg.
- Training & Devel Specialist	204.0	0.1	Grow about as fast as avg.
Computer/Math Occupations 16	2,932.8	2.3	
- Computer Programmer	585.0	0.4	Grow about as fast as avg.
- Computer Software Engineer, ADDI	380.0	0.3	One of fastest growing jobs
- Computer System Analyst	431.0	0.3	One of fastest growing jobs
- Data Base Administrator	106.0	0.1	One of fastest growing jobs
- Mathematician	3.6	0.0	Declining
Engineering Occupations 31	2,279.7	1.7	
- Aerospace	50.0	0.0	Grow as fast as avg.
- Electrical/Electronic	357.0	0.3	Favorable growth
- Industrial	126.0	0.1	Grow as fast as avg.
- Electrical/Electronic Tech	519.0	0.4	Grow as fast as avg.
Life/Physical & Social Science 39	1164.0	0.8	
- Physicist & Astronomer	10.0	0.0	

- By 2010, employment in the Computer Software Engineer occupation is expected to double to 760,000; and Computer Systems Analyst occupation is expected to rise by 60% to 689,000.

The examination of the occupations where simulator professionals arc found indicates that a relatively small proportion of the workforce could be classified as simulation professionals. However, of the occupations closely linked to simulation, many are among the fastest growing occupations in the U.S.

ISSUES

After examining the available government information on industries and occupations, it is clear that there is little specific data that isolates simulation from other related activities.

The analysis does demonstrate the complexities of defining simulation in the economy. In doing so it raises several issues. These issues are meant to stimulate a discussion on how simulation fits into the economy.

- How can a "simulation industry" be described when there is broad activity embedded in both manufacturing and service industry sectors? What does the proportion of simulation in manufacturing compared to the proportion in services indicate? Can simulation be characterized as a new and emerging industry?

- How significant is the overall simulation business in the economy? What do the proportions of simulation employment to total employment for detailed manufacturing industries indicate? For services industries?
- What can be said about simulation within each industrial sector? Is it homogenous or heterogeneous? Is there a detailed industry within each sector that is dominant?
- What is the level of specialization? What are the distinct manufacturing processes and/or products that are unique to simulators? Are simulator businesses engaged in the production of advanced technologies? In the services sector, what are the distinct areas of expertise and/or knowledge that are uniquely provided by simulation businesses?
- What is the coverage of simulation activity in that the economic significance, the specialization, and the coverage of simulation activity warrant simulation being considered for more specific inclusion in the industrial classification system. (Ref 7)

Research into occupational titles should further explore the four identified occupational groups. The NCS/NTSA survey recommendations as reported in the NCS survey report that call for the development of one or more occupational descriptions to define job requirements for simulation professionals should be examined. Information should be prepared to inform the OMB's Standard Occupational Classification Policy Committee that will recommend changes in the SOC definitions and placement of new occupational codes. The analysis should take into account the criteria established for revising the SOC.

CONCLUSION

At a time when society is beginning to realize the major role being played by simulation, an opportunity exists to advance the recognition of modeling and simulation activity in economic terms. While the magnitude and characteristics of simulation activity are still largely unknown, simulation businesses are known to be both in manufacturing and services industry sectors. The simulation workforce is distributed largely among management, computer/mathematical, engineering, and scientific occupations. The debate should begin now about how to define modeling and simulation in more specific industrial and occupational terms. The Society for Modeling and Simulation together with other professional societies should take the lead role in spearheading the effort to prepare for 2005 when the industrial and occupational coding structures will be revised.

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BIOGRAPHIES

Vince Amico started his career in simulation when he joined the Special Devices Center in 1948 as a Project Engineer in the Flight Trainers Branch. He was promoted to Branch head, Division head, and then to Chief Engineer of the Special Projects Office. In 1969 he was selected for the Position of Director of Engineering at the Senior Executive level. He was assigned to the position of Director of Research in 1979. He retired in 1981. Since then, he has done consulting, taught short course on simulation, and presented Papers at SCS and I/ITSEC Conferences. He has been a member of the Board of SCS and also served as VP, Conferences. He is a member of AFCEA, AIAA, NDIA, and SCS. He holds B of AE, MBA and MSE degrees. He is a member of Tau Beta Pi, Alpha Pi Mu, and Sigma Xi, The Research Society of America. He is the

Industrial Affiliates Coordinator for the School of Computer Science at UCF. He has been a founding member of the Board of Directors of the National Center for Simulation and is now the Co-Chair of its Technology Committee.

Lorraine Amico Grace has analyzed literacy, workforce, and information policy at the national, state, and local levels for the past 25 years. Ms. Grace conducted research and policy analysis at the National Governors Association from 1981 until 1995. Prior to joining NGA, Ms. Grace was employed as an economist and researcher at the state and local levels in Florida. She has written numerous publications in the areas of literacy, human resource planning, system integration, performance management, and information policy. She participated in several advisory groups for statistics, workforce, and education agencies. As a member of the American Statistical Association, she served on the Government Statistics Committee. Currently she owns a small consulting business. She was awarded a Master of Science degree in sociology from Florida State University in 1974.