Technical Report CS76010-E

A COMPARISON OF DISCRETE EVENT SIMULATION COURSES BASED ON A SMALL SAMPLE SURVEY*

Richard E. Nance

August 1976

Department of Computer Science
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

*This study was commissioned and supported in part by the College on Simulation and Gaming of The Institute for Management Sciences.

INTRODUCTION

Simulation is recognized as a popular management science/operations research technique. According to the study by Shannon and Biles [1], simulation ranks third, behind general statistical techniques and economic analysis among OR/MS practitioners. The popularity of simulation extends into the social sciences [2, 4, 14], agriculture [3], water resource planning [15], and business [8, 9], and this list of disciplines is only a sample. Perhaps it is the ubiquitous nature of simulation that leads to feelings of discomfort regarding the use of the term in an environment outside one's own particular discipline. Simulation is perceived quite differently by different persons within the same discipline, and even more disparate views are held by persons in different disciplines.

Several studies have been directed toward assessing the characteristics, use, and comparison of simulation programming languages (SPLs). Early studies of SPLs [7, 12, 13] have been rendered obsolete by the pace of language development. More recent studies attempt to gauge the users' perceptions of comparative language capabilities [5, 6] or to recognize trends in language design [1]. What has been lacking, however, is a comparison of the subject content of "simulation courses" through which future practitioners formulate their conceptions and assimilate much of their knowledge of the technique. This paper explores the similarities and differences among simulation courses offered in a few major colleges and universities.

Objective of the Study

The study described in this paper began initially as part of a dual effort involving (1) a comparison of the practitioners' views of the necessary skills and knowledge to use simulation with the academic views as reflected by course

content and (2) the identification of similarities and differences in courses taught in major colleges and universities. At the Joint ORSA/TIMS meeting in San Juan, Puerto Rico on October 16-18, 1974, comparative results of two surveys reflecting these objectives were presented under the titles:

(1) Survey of Simulation Education I: The Perceived Need, and

(2) Survey of Simulation Education II: Today's Response.

The purpose of this paper is more specific, namely: to assess the similarities and differences among courses offered by departments within larger academic units bearing the same name and to measure the differences among the courses offered in larger academic units with different names. In subsequent paragraphs we use the term "college" to identify the larger academic unit.

Issues Relating to the Differences in Courses Within and Among Colleges

The remainder of this paper deals with four specific issues relating to examination of the results of the sample survey. In each instance differences within and among colleges are investigated with respect to:

(1) the academic level of simulation courses,

(2) the breadth or narrowness in the backgrounds and interests of students enrolled in the courses,

(3) the nature and degree of attention given to programming languages, primarily SPLs, and

(4) the relative emphasis given to topical areas comprising the content of the courses.

Hopefully, these results furnish a better understanding of the composition of simulation courses and indicate the degree of commonality in courses offered by departments within and without colleges bearing the same names.

SAMPLING DESIGN

Questionnaire Construction

A copy of the questionnaire used in the sample survey is provided in Appendix A. The questionnaire was constructed in accordance with the following design criteria:

(1) The intent was to use closed-ended questions with an attempt to be nearly exhaustive in the possibilities permitted for answers.

(2) The questionnaire was to be simple and require little time for completion; thus a multiple choice format was selected with major dependencies among questions exhibited only in one part - the topical areas emphasized in the course.

(3) No attempt was made to build internal consistency checks; for example, no check was made for the addition of topical area percentages to total 100 percent. Further, no specific consistency questions were included.

As a pretest of the questionnaire, an earlier version was mailed to six selected members of the TIMS College on Simulation and Gaming. These pretest respondents were asked to supply their reactions and suggestions concerning the clarity of questions, completeness of the questionnaire, difficulty of answers, time required for completion, and the specificity of questions with regard to meeting the expressed objectives. Compared to the earlier version, the example in Appendix A is more closed-ended and somewhat shorter.

Questionnaire Distribution

Potential questionnaire respondents were identified as all members of the TIMS College on Simulation and Gaming together with colleagues known to be instructors in simulation courses offered at several universities. Additionally, announcements were placed in Simuletter (the newsletter of SIGSIM, the Special Interest Group on Simulation of the Association for Computing Machinery) and OR/SA Today. These announcements provided instructions regarding making a

request for a questionnaire. Finally, included in the cover letter to the questionnaire was a request for circulation of copies of the questionnaire among colleagues teaching simulation courses and the identification of other persons teaching such courses.

Questionnaires were mailed in July, 1974 with the cover letter requesting response by September 1, 1974. Sixty-three questionnaires were mailed initially with subsequent identification and requests increasing this number by five giving a total of 68.

The response to the questionnaire separated by colleges was as follows:

Arts and Sciences	- 7
Business	- 11
Engineering	- 13
Other	- 5
Total	36

From the total of 36, one response from Arts and Sciences and one from Engineering were omitted in part since the answer to question 8 dealing with topical emphasis indicated a failure to note the reverse side of page 1. One response in Business was omitted completely because the course, which had the title "Intermediate Statistics", devoted 50 percent of its emphasis to decision analysis. The category described by "other" above includes one commercial venture and four departments not falling within the designated college divisions. Thus, the following results are based in part on responses from thirty courses believed to deal primarily with the subject of discrete event simulation.

COURSE PROFILES

Perhaps a "flavor" of simulation courses can be gained by looking at the titles. Table 1 provides a comparison of the titles of courses responding

in each of the three collegiate divisions defined for this study.

Arts and Sciences	Business	Engineering
Simulation Principles	Management Simulation	System Simulation
Simulation Techniques	Computer Simulation	Principles of Scientific Modelling
Modelling, Simulation, & Gaming	Simulation Theory	Simulation: Theory and Methodology
Discrete Event Simulation	Computer Simulation Techniques	Simulation of Industrial Engineering Systems

Table 1. Comparison of Course Titles Used Among the Three Colleges

The titles shown in Table 1 reflect both specificity and generality in treatment. While some examples bear an identification of the college, most indicate little about either the college or departmental unit.

In the discussion that follows several abbreviations are used. A complete list of all abbreviations is given as Appendix B. However, in most instances the more complete designation or term precedes the abbreviation on the first usage. Individual courses are identified by a six symbol code to provide the anonymity guaranteed in the questionnaire.

Academic Level of Simulation Courses

The academic level of simulation courses in each of the three colleges is shown in column 2 of Tables 2, 3, and 4 for Arts & Sciences, Business, and Engineering respectively. The most common academic levels appear to be:

(1) senior-graduate (S/G) in Arts and Sciences, with a variation from sophomore (SO) to first year graduate (G/1);

(2) advanced-graduate (AD/G) in Business, although courses at the senior (SR) and senior-graduate (S/G) level are identified;

(3) first year graduate (G/1) in Engineering, which is descriptive of six cases, but S/G is also used in four cases.

In addition to the classification level, another level indicator is the number and nature of prerequisite knowledge (column 5 in each table). (Note again that

Code	(1) Dept	(2) Level	(3) % Major	(4) Other Dept. Using	(5) Prerequisite Knowledge Required	Languages (6) One Emphasized	(7) Discussed or Used
BTXXQC	CS	G/1	100	-	Prog. in higher level lang. (Phll)	GPSS	Fortran
BBRXUS	CS	JR	70	OR,Bus,Math Engr	Phll, basic prob. (Prob), basic stat. inference (Infr)	EASYSIM	SIMSCRIPT II, GPSS, GASP, Fortran, CSMP
CUCXUG	CIS	S/G	80	MS	Phll,Prob,Infr Other	GPSS	SIMSCRIPT II, ECSS
OCXBGU	CS	S/G	80	MS,Bus,Math, Stat	Phll, Calculus	GPSS	SIMSCRIPT II, GASP, Fortran, CSMP
SWJXHC	CS	SO	-	Math,Stat, Science, Pre-Engr	Phll,Prob,Infr, Quantitative Science	GPSS	CSL, Fortran
SSXVSU	CS	S/G	50	OR,Bus,Math, Stat,IE,Engr, Phys, Psyc	Phll, Prob, Infr	-	SIMSCRIPT II, GPSS
FSGUNC	OR	S/G	90	CS, Stat	Phll, Prob, Infr	-	SIMSCRIPT II, GPSS

Rable 2. Profile of Courses Offered in Colleges of Arts and Sciences

Code	(1) Dept	(2) Level	(3) % Major	(4) Other Dept. Using	(5) Prerequisite Knowledge Required	Languages (6) One Emphasized	(7) Discussed or Used
SLSUMX	MS	AdG	30	Bus,Stat	Prog. in a higher level lang (Phll) preferred, basic stat inference (Infr), opns. res. (OR)	GPSS	SIMSCRIPT I.5, Fortran
SAXXHU	ACS	SR	40	CS,MS,Bus,IE	Phll, basic prob (Prob), Infr	GPSS	SIMSCRIPT II, Fortran
MLHUPX	DS	G/1	60	CS,MS,OR,Bus	Phll, Prob, Infr	-	SIMSCRIPT II, GPSS, PL/1, GASP, SIMULA 67, ECSS.
MRJUCX	QA	AdG	50	Bus,Math,Econ Biology	Phll, Prob, Infr	SIMSCRIPT II	-
JDRUNC	QA	G/1	60	CS,OR,Bus	Phll, Prob, Infr	GPSS	SIMSCRIPT II
HJXCSF	QM	SR	20	CS, Bus	Phll, Prob, Infr	GPSS	-
DMJNYU	MGT	AdG	50	CS,MS,OR,Bus Stat,IE,Econ, Mktg,Fin,MIS, QA,Acct	Phll, Prob, Infr	-	SIMSCRIPT II, GPSS, Fortran, PL/1, SIMSCRIPT I.5
BERTUX	MS	AdG	75	CS,MS,OR,Bus, Math,Stat,IE, Engr	Phll, Prob, Infr,	GASP	GPSS, Fortran
PDFXUA	OR	S/G	80	Bus,Math,Stat, IE,Engr	Phll, Prob, Infr, Basic Systems Theory	GASP	GPSS, Fortran
DGDUNC	QA	AdG	50	CS,OR,Bus, Planning, Public Health	Prob, Infr, Quant. Methods	GPSS	-

Table 3. Profile of Courses Offered in Colleges of Business

Code	(1) Dept	(2) Level	(3) % Major	(4) Other Depts. Using	(5) Prerequisite Knowledge Required	Languages (6) One Emphasized	(7) Discussed or Used
ZHSXWV	IE	G/1	87	CS,Math,Engr	Prog. in a higher level lang. (Phll), opns. res. (OR), adv. stat. (exp dsgn).	GPSS	SIMSCRIPT I.5, Fortran
YDXGTX	IE	JR	80	CS,MS,OR, Bus,Engr	basic prob. (Prob), basic stat. inference (Infr),	GPSS	-
SBXXNU	IE	S/G	50	CS,MS,OR, IE,Engr	Phll, Prob	-	SIMSCRIPT II, GPSS, Fortran, FLIPS, PIMP
SGRSUX	IE/CS	G/1	85	CS,MS,OR,Bus, IE,Engr,Econ, For	Phll, Prob, Infr	GPSS	-
RJXXUB	IE	G/1	50	CS,MS,OR,IE, Engr	None	GPSS	-
PBAPUX	IE/AA	S/G	90	CS,Bus,Engr, Psyc	Phll, Prob	GASP	SIMSCRIPT I.5, GPSS
MGAUPI	SE	S/G	50	CS,MS,OR,Bus, Math,Stat, Engr,Econ, Psyc,Pol Sci, Soc,& others	Phll, Prob	-	SIMSCRIPT II, GASP, CSMP, DYNAMO II
MAZPUX	SE	G/1	50	CS,MS,OR,Bus, Stat,Engr	Phll, Infr	-	GPSS, GASP, DYNAMO II
HARUNH	IE	AdG	90	CS,OR,Bus	Phll,Prob,Infr,OR, Queueing Theory	GASP	SIMSCRIPT II, GPSS
GVASCX	IE	AdG	100	OR	Phll, Prob, Infr	-	GPSS, Fortran
CAJCUX	SE	G/1	50	MS,OR,Bus, Math	Phll, Infr	-	GPSS, Fortran
SMJNCE	CS	S/G	85	Bus,Math,IE, Engr	Phll, Prob, Infr	GPSS	Fortran
WWXXCU	OR	G/1	95	CS,MS,OR,IE, Engr	Phll, Prob, Infr	-	SIMSCRIPT II, SIMSCRIPT I.5, GPSS, Fortran, DYNAMO

Table 4. Profile of Courses in Colleges of Engineering

abbreviations in column 5 are given more fully the first time used, and all are defined in Appendix B). The principal conclusion with regard to prerequisite knowledge is the consistency within and among colleges. Three specific knowledge areas predominate: (1) programming in a higher level language, (2) basic probability, and (3) basic statistical inference. These three knowledge areas are named in five courses in Arts and Sciences, eight in Business, and five in Engineering. Considering the possible number of identifications of these three to be the product of the number of courses included in the survey (30), we find 73 occurrences among the 90 possibilities. Of course other prerequisite knowledge areas are mentioned, and some courses provide notable exceptions, e.g. the G/1 course in Table 4 with no prerequisites. In general, no strong relation between level and prerequisites is apparent, although some individual courses do reflect this dependency, e.g. the advanced graduate course coded HARUNH in Table 4.

Breadth/Narrowness of Student Interest and Background

Rarely is a course limited to students of the department offering the course (see columns 3 and 4 of Tables 2, 3, and 4). This occurs in only two cases in 30--once with a computer science department (CS) and once with an industrial engineering department (IE). In most cases at least two other departments supply students to the course, and both Business and Engineering show a larger number of departments being served than does Arts and Sciences.

Column 3 in each table gives the enrollment percentage for the offering department. The average enrollment by students in the offering department is 78% (A&S), 52% (Bus), 76% (Engr). Business demonstrates a marked difference from the other two; however, the exclusion of class sizes from the questionnaire prohibits a judgment regarding the relative number of students affected.

PROGRAMMING LANGUAGE USE

The identification of language treatment with specific courses is given in Tables 2, 3, and 4, but a more descriptive comparison of emphasis on a single language is provided in Figure 1. Similarly, the assessment of differences, if any, in the languages discussed and/or used is provided by Figure 2.

Emphasis on a Single Language

Figure 1 clearly illustrates the dominance of GPSS in courses emphasizing a single language. GPSS appears as the most pervasive simulation programming language in all colleges with no apparent difference in degree. The lack of appearance of GASP in A&S compared with Bus and Engr probably stems from the opinion that this Fortran-based simulator can be easily grasped by CS students, who have had much prior exposure to languages and data structures. The proportion of courses emphasizing no single language in Engr is surprising.

Languages Discussed and/or Used

The pervasiveness of GPSS among SPLs is reflected in Figure 2 as well. GPSS is discussed and/or used to some extent in over 90% of all reported courses. SIMSCRIPT II is likely to receive more emphasis in the CS-dominated courses in A&S because of its greater descriptive power, more elegant constructs and general purpose applicability. The "other" category also is larger in A&S, and the principal languages included here are CSMP and CSL. The "other" category in Engr is only one-half the size of that in A&S and includes CSMP but no CSL. SIMULA 67 is mentioned in only one course, offered in Business.

RELATIVE EMPHASIS ON TOPICAL AREAS

The interpretation of Figure 3 is divided into two parts--comparisons within colleges and among colleges. The bar chart pictured in Figure 3 marks the maximum and minimum percentages reported in each college sample. Thus a wide (or long) bar indicates a high level of variability within a college. Dotted lines within each bar mark the average reported percentage for the college. The circles and small x designate a value to be explained later. Keep in mind that within college variability is indicated by the width (or length) of the bar and differences among colleges by the variation among the reported averages. The within college variability can be caused by an "outlier" effect, which is indicated by the average appearing far from the middle of the bar. Broad variability is recognized by a wide bar with the average appearing near the middle.

Within College Differences in the Emphasis in Topical Areas

Courses taught in business exhibit the least within college variability. Other than programming languages, the next largest area in Business is internal model organization which ranges from 0 to .15. Courses taught in Engineering exhibit the largest variability, with broad variations evident in the time allocated to random number generation, statistical methods for output analysis and event scheduling. Variability, attributable at least in part to an "outlier" effect, is seen in statistical methods applied to input data, output and report generation and the inclusion of other topics (topics not listed among the questionnaire categories). For A&S, other than in the treatment of SPLs, broad variability is evident in the time allocated to principles, internal model organization, and statistical methods applied to input data. Variability traceable at least in part to the "outlier" effect is evident in statistical

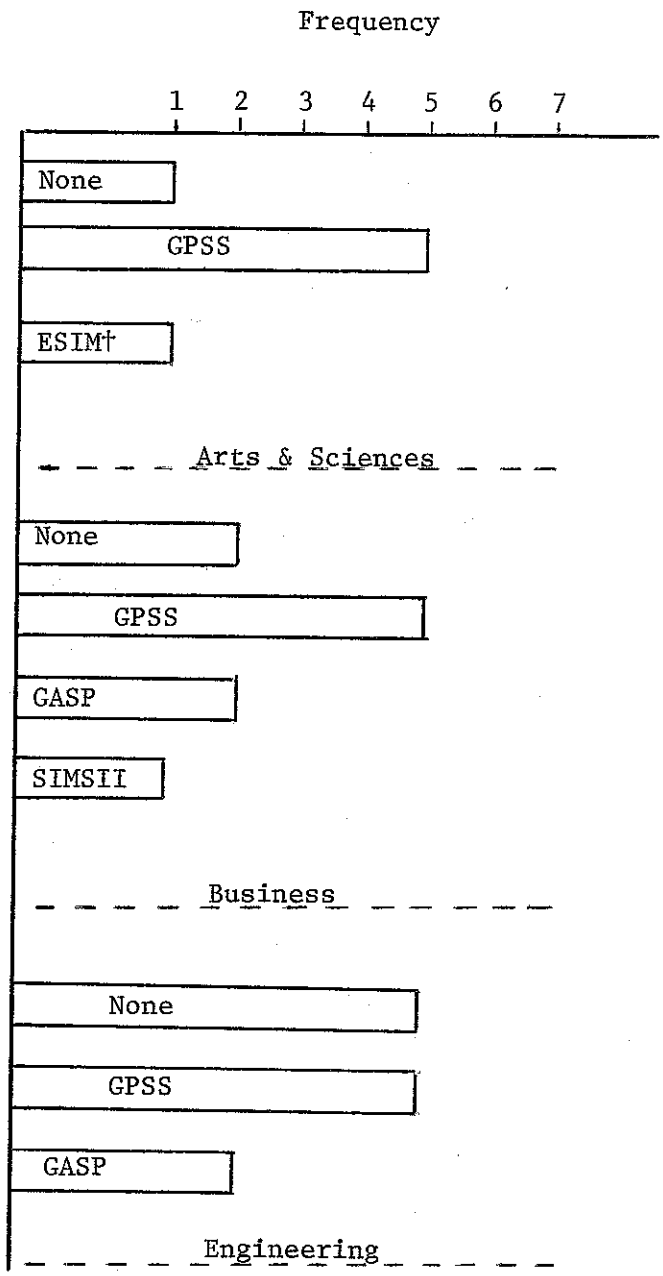

Figure 1. Comparison of Language of Emphasis by College

†ESIM = EASYSIM

*SIMSII = SIMSCRIPT II

methods for output analysis and the relationship to other forms of simulation.

From the topical area perspective, the treatment of SPLs causes the greatest variability in all three colleges. This variability is broad (a wide bar with the average appearing near the middle), indicating a true lack of agreement. Another topical area evidencing some variability is the statistical methods for output analysis, but the variability in this area is neither as pronounced nor as broad as that of SPLs.

Variability Among the Colleges in the Emphasis Given to Topical Areas

The emphasis allocated to programming languages marks the major difference among topical averages for each college. While the average for courses in A&S is .23, that for Bus is .19 and for Engr only .14. In fact, other than SPLs no other area exhibits marked differences. The category of "other topics", in which Engr averages .09 while A&S and Bus average .04 and .03 respectively, provides the largest magnitude deviation. As noted above, the Engr average is affected by the "outlier effect", and with a single reported value removed, an average of .05 is the result. As an aside, the magnitude of these values (around .05) encourages the conclusion that the topical areas identified in the questionnaire covered the subject content rather well.

Variability Among Similar Departments in Different Colleges

The sample of responses provided the opportunity to compare courses offered in operations research departments located within each of the three collegiate divisions. Also, a single CS department reporting within Engr, provides the opportunity to compare courses carrying the same departmental designation but with the departments located in different colleges.

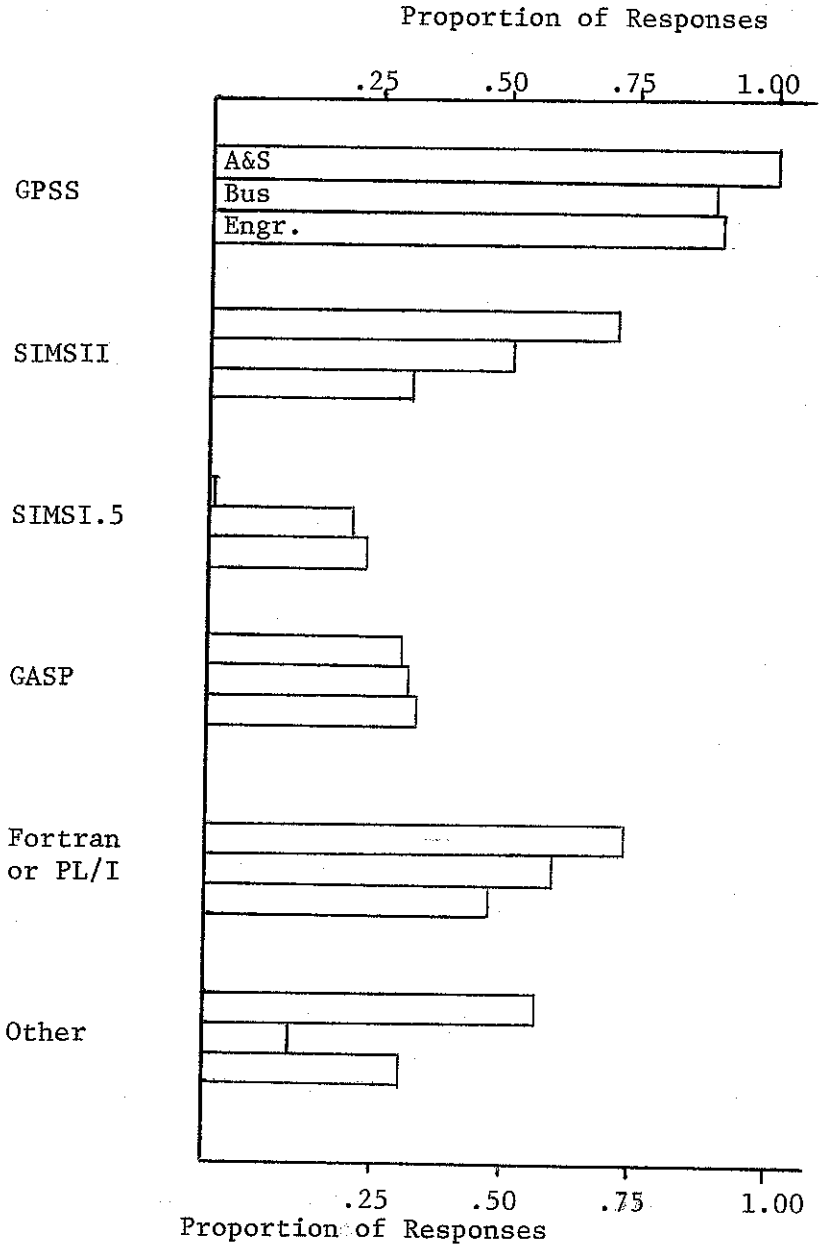

Figure 2. Proportionate Comparison of Languages Discussed or Used*
(The ordering remains the same for each group of three as shown in the first group.)

*Includes the language of emphasis, if any.

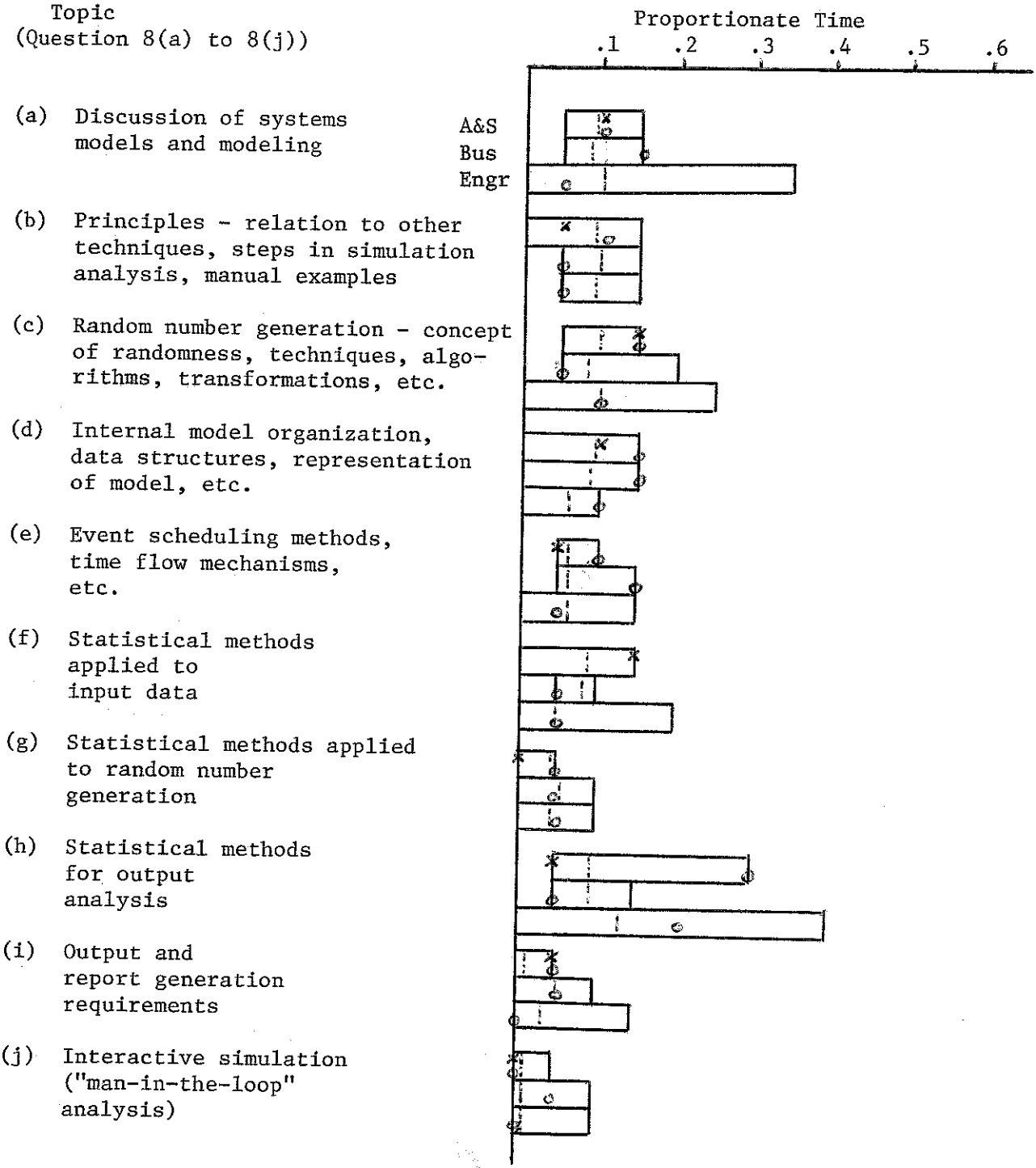

Figure 3. Proportionate Time for Topics--A Comparison. (The ordering remains the same for each group of three as shown in the first group.)

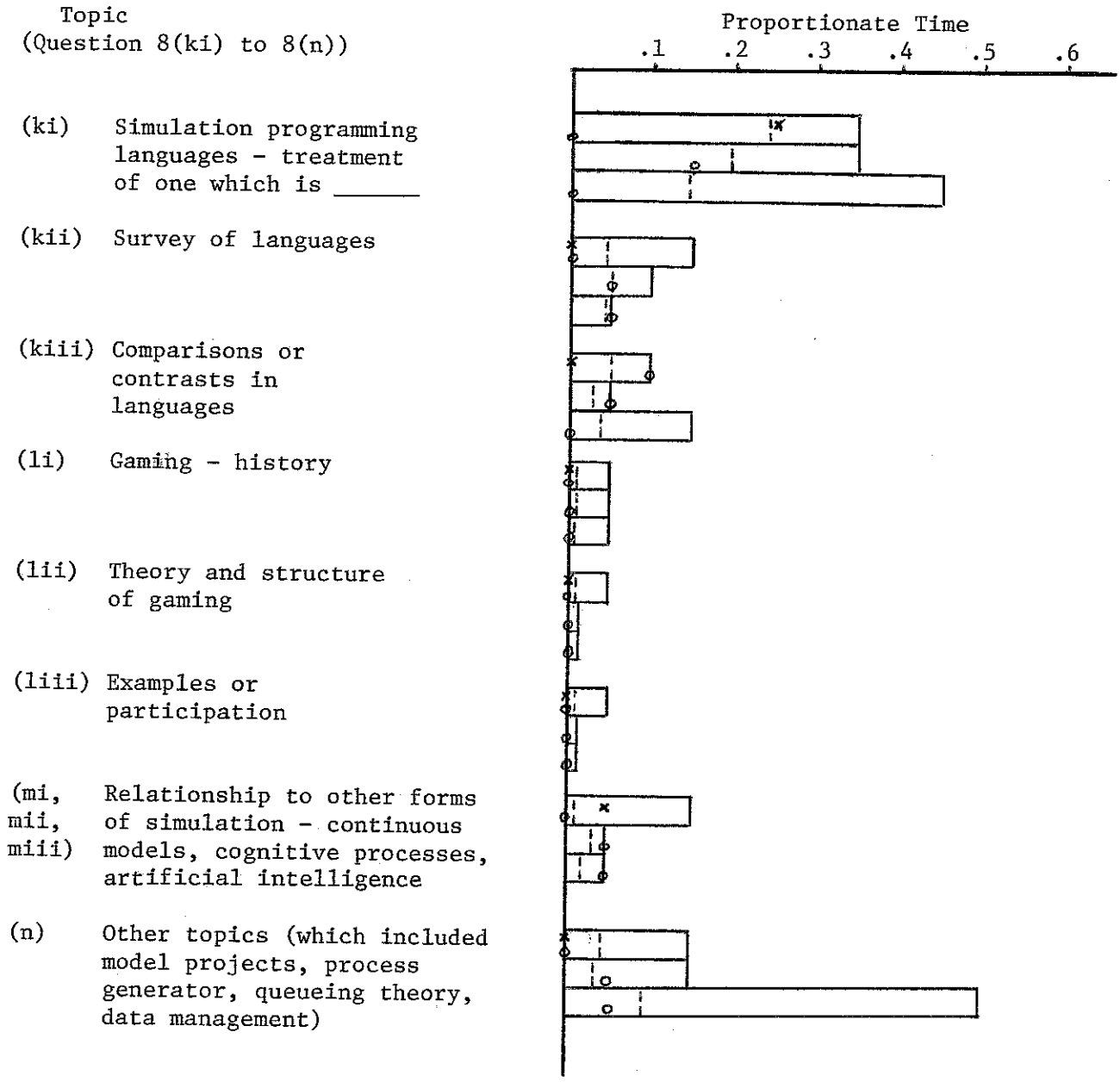

Figure 3. Proportionate Time for Topics -- A Comparison (continued).

Differences Among Operations Research Departments

Note the presence of one OR department in each of the three colleges reporting courses in Tables 2, 3, and 4. The response in each of the topical areas shown in Figure 3 is designated by a circle for the OR department within each college. The intent is to investigate whether these departments, presumably with quite similar goals, objectives, and perspectives with regard to simulation as it relates to the remainder of operations research, exhibit less differences among themselves than shown among other courses in the same college. Judgments must be made with caution, however, since the sample size itself can affect the variability measured by examining averages among colleges.

The allocations of time among the three OR departments are very similar except in two areas: statistical methods for output analysis and SPLs. Both of these areas exhibit high variability within A&S and Engr. Discounting these two areas, the OR departments exhibit less differences among themselves than in comparison with courses in other departments within their respective colleges.

Differences Between CS Departments in A&S and Engr

A course from a single CS department reporting within Engr is compared with the majority of responding courses in CS departments which are in A&S. This comparison is shown in part by marking the reported value of the lone CS course in Engr with a small x on the bar for A&S. (Note that one responding OR department is included in the aggregate A&S values; however, this slight bias can be visually removed by noting the circled value in the A&S bar. To assess the closeness of the relationship between the lone CS/Engr course and the CS/A&S courses, two "ad hoc" but convenient measures are defined:

(1) a count of the number of topical areas in which the CS/Engr value lies closer to the A&S average than the lone OR/A&S value and vice versa; and

(2) a count of the number of topical areas in which the CS/Engr value lies closer to the A&S average than the Engr average and vice versa.

The result is given in Table 5 and indicates that no close relationship among the CS departments regardless of college can be claimed. The CS/Engr course exhibits no closer relationship to the A&S courses than does the OR/A&S course. Further, the CS/Engr course appears to have no closer relationship to the A&S courses than to the other Engr courses. Of course, the size of the sample causes considerable caution with this conclusion as well as all others.

		CS/Engr Course Value		
		Closer	Further	No Difference
(1)	Comparison with OR/A&S course value	4	4	10
(2)	Comparison of distance between A&S average as opposed to Engr average	5	6	7

Table 5. Ad Hoc Measures of the Relationship of the Single CS/Engr course to the CS/A&S courses.

SUMMARY AND CONCLUSIONS

The results reported here are couched within the qualifications mandatory for a small sample of 31 discrete event simulation courses. However, this study is the first to attempt an assessment of the content and composition of simulation courses and to compare courses within and among the contexts of their academic administrative units.

Several conclusions are warranted from the study:

(1) Simulation courses tend to be offered at a higher classification level in Business (advanced graduate) than in Engineering (first year graduate) or Arts and Sciences (senior/graduate). Variations in the classification level are indicated in all three colleges.

(2) A surprising consensus in prerequisite knowledge exists among the courses offered in all colleges: (1) programming in a higher level language, (2) basic probability and (3) basic statistical inference.

(3) Simulation courses usually serve a student population having a variety of backgrounds and interests. This heterogeneity is more pronounced in Business where the students from the offering department on the average number only 52 percent of the course enrollment.

(4) If one SPL is emphasized, the language is GPSS by a wide margin in all colleges. Among the languages discussed and/or used, SIMSCRIPT II appears frequently in A&S. The courses offered in A&S, which are predominantly from CS departments, include a larger number and variety of languages (discussed and/or used).

(5) The major difference among courses offered within the same college is found in the time allocated to SPLs. The statistical methods for output analysis is the area with the next highest variability. Over the eighteen topical areas in total, courses offered in Business exhibit the least variability and those in Engineering the most.

(6) The principal difference among colleges is again in the time allocation for SPLs, with averages of .23 (A&S), .19 (Bus) and .14 (Engr). In the time allocated to "other topics" the effect of an "outlier" causes an apparent discrepancy, i.e. an average of .04 (A&S), .03 (Bus), and .09 (Engr). Removal of the outlier reduces the average for Engr to .05, indicating much more consistency.

(7) Investigation of courses offered in departments with the same name but located within different colleges reveal differences among courses offered in OR departments again in the time allocated to two areas: SPLs and statistical methods for output analysis. Discounting these two areas the courses in OR departments exhibit less differences among themselves than they do in comparison with other courses in their respective colleges. Comparison of a single CS course within Engineering with the courses offered in A&S, which are predominantly CS, reveal no closer relationship between the CS/Engr course and the A&S courses than was apparent between that course and other Engr courses.

The conclusions expressed above are investigated further in a study more narrowly focused on courses offered in CS departments [10]. That study includes a larger sample survey using the same questionnaire.

APPENDIX A

TEACHERS QUESTIONNAIRE

Date:_____ Name:_____ Title:_____ University:_____

1. Title of the course:

2. School, division or college in which the course is taught:

__Arts and Sciences __Mathematical Sciences __Engineering __Applied Sciences __Business __Other(Please specify)

3. Department in which the course is taught:

__Computer Science __Industrial Engineering __Operations Research __Quantitative Analysis __Other(Please specify)
__Management Science __Administrative Sciences __Mathematics __Statistics

4. Prerequisite knowledge expected in the course (check all that apply):

__Previous simulation course __Programming in a higher level language __Programming in an assembler
__Basic probability __Basic statistical inference __Operations research techniques __Quantitative methods
__Advanced probability and/or statistics __No prerequisites __Other than listed here

5. Students taking the course come from the following disciplines (check all that apply):

__Computer Science __Management Science __Operations Research __Business __Mathematics __Statistics
__Industrial Engineering __Other Engineering __Other (Please specify all) _____

6. Students from the department offering the course constitute approximately what percentage of the enrollment? _____% The two departments contributing the highest percentage of students are _____ ___% and _____ ___%.

7. The level of the course is:

__Sophomore __Junior __Senior __Senior and graduate __First year graduate __Advanced graduate

8. Indicate the percentage of time allocated to each topical area below:

	0	5	10	15	20	25	30	35	40	45	50	55	60
a. Discussion of systems, models and modeling	__	__	__	__	__	__	__	__	__	__	__	__	__
b. Principles--relation to other techniques, steps in simulation analysis, manual examples, etc.	__	__	__	__	__	__	__	__	__	__	__	__	__

	0	5	10	15	20	25	30	35	40	45	50	55	60
n. Other topics (Please specify)													
i. _____	—	—	—	—	—	—	—	—	—	—	—	—	—
ii. _____	—	—	—	—	—	—	—	—	—	—	—	—	—

9. Programming languages or packages discussed and/or used in the course.

__SIMSCRIPT II (any version) __SIMSCRIPT 1.5 __GPSS (any version) __GASP (any version) __SIMULA 67
__SIMULA __SIMPL/I __SOL __ECSS __CSL __FORTRAN __PL/I __ALGOL __Assembler __Other (Please specify) _____

10. Do you wish to receive a copy of the summary report of the data compiled from this questionnaire?
Yes ___ No ___

REFERENCES

1. Adriano, A., B. Martinoli, M. DeMattia and C. Varalli. "Simulation Languages: From Batch to Conversational Mode," Operational Research '72, North Holland Publishing Co.: Amsterdam, 1973.

2. Coplin, W. D. (ed.). Simulation in the Study of Politics, Markham Publishing Company: Chicago, 1968.

3. Eidman, Vernon R. Agricultural Production Systems Simulation, Proceedings of a Workshop, May 4-8, 1970, Oklahoma State University: Stillwater, May 1971.

4. Inbar, M. and C. S. Stoll. Simulation and Gaming in Social Science, The Free Press: New York, 1972.

5. Kleine, H. "A Survey of User's Views of Discrete Simulation Languages," Simulation, 14(5): 1970, 225-229.

6. Kleine, H. "A Second Survey of User's Views of Discrete Simulation Languages," Simulation, 17: August, 1971, 89-92.

7. Krasnow, H. S. and R. A. Merikallio. "The Past, Present and Future of General Simulation Languages," Management Science, 11: November, 1964, 236-267.

8. Meier, R. C., W. T. Newell and H. L. Pazer. Simulation in Business and Economics, Prentice-Hall, Inc.: Englewood Cliffs, 1969.

9. Naylor, T. H. Computer Simulation Experiments with Models of Economic Systems, John Wiley & Sons: New York, 1971.

10. Overstreet, C. M. and R. E. Nance, "A Survey Perspective on Computer Simulation Course Content," Technical Report CS76011-E, Department of Computer Science, Virginia Polytechnic Institute and State University, Blacksburg, September 1976.

11. Shannon, R. E. and W. C. Biles, "The Utility of Certain Curriculum Topics to Operations Research Practitioners, Operations Research, 18 (4): July-August, 1970, 741-745.

12. Teichroew, D. and J. F. Lubin. "Computer Simulation--Discussion of the Technique and Comparison of Languages," Communications of the A.C.M., 9: October, 1966, 723-741.

13. Tocher, K. D. "Review of Simulation Languages," Operational Research Quarterly, 16: June, 1965, 189-217.

14. Tomkins, S. S. and S. Messick. Computer Simulation of Personality, John Wiley: New York, 1963.

15. Vansteenkiste, G. C. (ed.). Computer Simulation of Water Resources Systems, Proceedings of the IFIP Working Conference, North Holland Publishing Co.: Amsterdam, 1975.

APPENDIX B

ABBREVIATIONS USED IN THE PAPER

Abbreviation	for Term or Designation
AA	Aeronautics & Astronautics
A&S	College of Arts & Sciences
Acct	Accounting
AdG	Advanced graduate level (course)
ACS	Administrative Computing Systems
Bus	College of Business
CIS	Computer & Information Science
CS	Computer Science
DS	Decision Sciences
Econ	Economics
Engr	College of Engineering
exp dsgn	experimental design
Fin	Finance
For	Forestry
G/1	First year graduate level (course)
IE	Industrial Engineering
Infr	Basic statistical inference
JR	Junior level (course)
Math	Mathematics Department
Mgt	Management
MIS	Management Information Systems
Mktg	Marketing
MS	Management Science
OR	Operations Research
Phll	Programming in a higher level language
Phys	Physics
Pol Sci	Political Science
Prob	Basic probability course
Psyc	Psychology
QA	Quantitative Analysis
QM	Quantitative Methods
SE	Systems Engineering
SO	Sophomore level (course)
Soc	Sociology
SR	Senior level (course)
S/G	Senior/graduate level (course)
Stat	Statistics Department