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Communications of the Association for Information Systems

TOWARD AN UNDERGRADUATE MIS CURRICULUM MODEL FOR CARIBBEAN INSTITUTIONS

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ABSTRACT

Colleges and universities in the United States with undergraduate programs offer undergraduate Management Information Systems programs in their business schools to complement and balance computer science and computer engineering curricula. Similar institutions in the English-speaking Caribbean, however, slant their computing studies overwhelmingly toward Computer Science , which produces technologists for the IT industry. Although the vast majority of their graduates are engaged in applying technology solutions to information problems in business organizations, these English-speaking Caribbean institutions offer limited MIS programs, which prepare graduates for such roles. This article examines undergraduate computing curricula in the Caribbean and compares them with others elsewhere in the world. It recommends that English-speaking Caribbean universities give similar prominence to MIS education in their business programs in order to equip graduates to create more effective IT-enabled business solutions.

KEYWORDS: MIS undergraduate curricula, branches of computing studies, Caribbean colleges, computer science/ engineering programs

I. INTRODUCTION

Most colleges and universities worldwide long recognized the need to compartmentalize their undergraduate computing programs into branches of study whose curricula design are dictated by, and harmonized with, placement objectives [Couger et al., 1995]. They typically offer three distinct braches of computing studies:

- computer engineering (CE) which is concerned with the design of computing machines;
- computer science (CS), the study and creation of technologies that enable computing machines to function; and
- management information systems (MIS), the study of the application of information technology (IT), the products of the other two branches, to the solution of business problems.

MIS programs, which are typically offered in business schools, permit focusing on technical and behavioral issues [Veneri, 1998] and organizational business processes.

The history of information systems (IS) delivery practices in business organizations is distinct from that of the underlying IT which it seeks to apply [Somogyi and Galliers, 2003]. Despite considerable IT advances, the persistent theme of the past ten to fifteen years is that the IS community of systems developers, users, and managers fails to exploit IT innovations to produce high-quality business applications consistently. This gap was referred to as the IS crisis by Brynjolfssen [1993] and Gibbs [1994]. The examples listed below support this contention and underscore the urgency of developing MIS curricula that focus specifically on preparing students to provide IS that apply IT solutions successfully to business problems:

- Mousinho [1990] described runaway IS delivery projects that were grossly over budget and hopelessly behind schedule.
- Niederman, et al. [1991] identified the improvement of IS delivery quality among the top ten IS management issues.
- KPMG Peat Marwick [Computerworld, 1994] found that over 50 percent of IS failed to deliver expected benefits.
- Kreitzberg, president of a software consulting firm claims that CIOs estimated the failure rate for IS projects at 60 percent [CIO Magazine, 1997].
- The Standish Group indicated that only 24 percent of IS projects in Fortune 500 companies were successful in 1998 [Software Magazine, 1999].
- Approximately 50 percent of IS executives surveyed by CIO Magazine [2001] expressed dissatisfaction with the quality of their organization's business software [CIO magazine, June 2001].
- Systems maintenance consumed 60 to 80 percent of organizational resources allocated to IS [Hoffer, George and Valacich, 2002].

This IS crisis seems even more pronounced in the English-speaking Caribbean (ESC). Attempts to solve it through curriculum design appear less energetic than those demonstrated by academic institutions elsewhere.

The author conducted three surveys (between 2000 and 2002) of 180 MIS graduate students, employed by over 50 ESC businesses, which indicated that organizations in the region made scant use of IS delivery techniques such as joint application development, prototyping, rapid application development, clean room software engineering, and agile development methods that were employed by IS professionals in other areas of the world in an attempt to alleviate the crisis. Lack of use stems largely from unfamiliarity with these approaches. Instead, ESC institutions focused more on providing CS programs although the overwhelming majority of their graduates are placed in business organizations.

The IS crisis is rooted more in human and organizational characteristics than in the technological implications of systems delivery, which makes MIS studies in business schools more likely to produce contributors to its solution [Amahdi and Brabson, 1998]. Holtzblatt and Beyer [1995] attribute the crisis mostly to miscommunication among IS providers and users, resulting from the lack of shared understanding of their respective domains. Using IT without first assimilating the dynamics of the business environment targeted for its application generally produces ineffective results because IS are delivered through socio-technical processes. [Orlikowski and Gash ,1994] and Robey et al.,2001]

The successful delivery of IS solutions requires a solid grasp of (at least) three areas: IT, organizational business processes, and human behavior:

1. IT is a key component of IS architecture, and its complementary co-requisites are business processes, and human and organizational issues [Lee et al., 1995; Lyytinen, 1988; Markus and Keil, 1994; McBride and Hackney, 2003; Newman and Robey, 1992; Tsichritzis, 1997]. The short half-life of IT increases the value of gauging the maturity and availability of emerging technologies to improve existing solutions and places a premium on technology knowledge.

2. Organizational business processes are the primary targets of IS. .Knowledge of organizational dynamics is necessary to understand and accommodate the often divergent interests of multiple stakeholders.

3. People skills are required to help solution providers assimilate socio-technical issues and work effectively in systems delivery teams.

Section II distinguishes among the three major branches of computing studies, to explain the focus, objectives, and target of each branch as a basis for analyzing computing curricula. Section III provides a brief history of the evolution of MIS curricula for undergraduate programs in the United States (US) and Canada, and a synopsis of computing curricula in 44 institutions selected randomly from 10 countries that share some historical, though somewhat obscure, affinity with the ESC. These countries are considered solid users of IS services. Section IV reviews the undergraduate degree programs in IT-related disciplines in all conventional ESC universities. This research and analysis are used in Section V to support the call for a reduction in the disparity in focus between CS and MIS programs and greater attention to MIS curricula in ESC institutions.

Several alternative terms are used in the literature to describe the key concepts discussed in this article. Table 1 gives the preferred terms used in this article, their meanings, and some alternatives that are encountered frequently.

Table1. Preferred Terms Used in This Article

Preferred Term	Meaning
Systems delivery Instead of: Systems development; software development; software engineering	Planning for, obtaining, and deploying an information system. This usage is meant to account for all the possible methods (in-house development, purchase, outsourcing, rental, etc.) of obtaining an information system.
Information systems (IS) Instead of: Software; computer-based information system; software system, computer application	A specific application of information technology to the solution of a business problem. This is a narrower usage than software that generally causes computing hardware to do work.
Management information systems (MIS) Instead of: Information systems (IS); computer information systems (CIS); Computer-based information systems (CBIS); information management (IM); informatics; information resources management (IRM); information science	The branch of computing study concerned with applying information technology to solve business problems, as distinct from computer engineering and computer science.
I**nformation systems crisis** Instead of: Software crisis; IS/IT paradox	The failure of information systems developers to consistently exploit the IT explosion to produce high-quality business systems; giving rise to the notion that there is an IT/IS effectiveness gap.

II. BRANCHES OF COMPUTING STUDIES

Many IT-related undergraduate degree programs exist under such titles as computer science, computer engineering, computer systems engineering, software engineering, network engineering and management, information systems, information security, electronic commerce, and educational technology. These programs can be classified into the three generic branches of study, CE, CS, and MIS that are customarily offered in engineering colleges**,** colleges of arts and sciences, and business or management schools respectively. However, several program/department permutations exist. For example, IT schools may accommodate all three branches, or CS may be offered by engineering schools. While these three major branches of study overlap somewhat, they differ in their areas of emphasis. The discussion of CE and CS below was supported by information from Soldan et al. [2004] and Cross et al. [2001] respectively.

COMPUTER ENGINEERING

CE is concerned with the design and construction of computing machines and with the use of switching circuits to provide real-time technology for automation and control functions. Students are exposed to hardware and system software concepts and how they work together. CE curricula overlap extensively with electrical engineering (EE) and CS programs. CS emphasizes circuit/software design relationships and interfaces, offering more algorithm and program development courses than EE, and more hardware-related topics than CS.

CE graduates are prepared for jobs in the design of architecture for computing machines (e.g., computer chips, circuits, and control systems), including computers embedded in physical products such as automobiles and appliances, and for solving industrial automation problems. Appendix I describes the body of knowledge generally covered in CE. In addition to the more technical content highlighted, some CE programs also offer courses such as database systems, social and ethical issues of computing, and human-computer interactions, which overlap with both CS and MIS offerings.

COMPUTER SCIENCE

CS is primarily a technical discipline that applies theoretical concepts of computability and algorithmic efficiencies as well as advanced electronics and design techniques to specific computational processes. This discipline differs significantly from most physical sciences, which usually separate the understanding and advancement of the science from its application and engineering implementation. Instead, CS promotes the interplay of theory and design to stimulate the generation of IT. Consequently, a great deal of attention is given to mathematics, natural sciences, computer architecture, and software engineering courses. Most CS graduates enter technology-producing companies as systema software designers of facilities such as database management systems, operating systems, and computational algorithms that computer hardware needs to function. Computer scientists produce computing technologies that are used by application specialists to solve business problems. Some of the crucial knowledge areas are indicated in Appendix II.

MANAGEMENT INFORMATION SYSTEMS (MIS)

MIS pertains to the application of IT to business problems. This activity can be viewed as technology-enabled business development [Gorgone et al, 2003]. MIS programs are offered under several other titles (Table 1). Each form incorporates technical and behavioral issues related to the delivery of organizational systems and the management of information resources and technical infrastructure [Maglitta, 1996]. MIS curricula draw from subject areas that span business concepts and themes [Baskerville and Myers, 2002]. The study of MIS is designed to prepare students to become internal business consultants and general corporate information solution providers in a variety of organizational contexts [McBride and Hackney, 2003].

MIS students are prepared to use technology as enabling tools for information processing systems that support the strategic priorities, general tactical operations, and decision-making in business organizations [Gill and Hu, 1999; Sahraoui, 1998]. The MIS business content normally includes the study of marketing and distribution; production, and finance for business enterprise; the economic and legal environment; the social and political influences of business; accounting and quantitative methods; organization theory; interpersonal relationship; communication and motivation systems; and administrative processes and policy determination in management [Ives et al., 2002; Nunamaker et al., 1982].

In the US and Canada, the Association for Advanced Collegiate Schools of Business (AACSB) prescribes this body of knowledge required for business accreditation. Appendix IV provides further information on institutional and/or program accreditation for the branches of study in the countries discussed in this article. The more technical content of typical MIS curricula are shown in Appendix III.

III. HOW EDUCATIONAL INSTITUTIONS ARE ATTEMPTING TO MEET THE IS CHALLENGE

The earliest business computing efforts involved using emerging IT to obtain an order-of-magnitude improvement in administrative efficiency and productivity in Accounting and Finance [Somogyi and Galliers, 2003]. Organizations launched “Data Processing” (DP) departments and staffed the development sections with professionals from their accounting and finance departments who demonstrated suitability for computer programming [Brown, 2002], on aptitude tests. Those selected were then trained in programming and systems analysis techniques. This approach produced effective results, initially, because these systems developers also possessed domain expertise in the business processes that were automated [Brown, 2002].

Gradually, the distinctive competence of these new departments eroded as the “pioneer” groups began to automate business processes outside their knowledge area in response to demand for services from other organizational units in what Tsichritzis [1997] called the second wave of computing. This requirement for more ambitious projects also caused DP departments to augment their staff with university graduates (from any discipline) who scored highly on the aptitude tests. The newer hires however, struggled to overcome fairly steep business and technology learning curves, which limited their early contributions. Computing services therefore fell short of expectations and discontent grew among users of IS services [Somogyi and Galliers, 2003].

As universities began to offer CS programs, the new IT “specialists” they produced were enthusiastically employed by business organizations with the expectation that they would enhance service quality and help to stem the growing tide of discontent among system users [Doke, 1999]. Some of these graduates were excellent technologists; however, they lacked the business knowledge to exploit technology fully to enhance organizational effectiveness. Nevertheless, they sometimes produced IS that were brilliant technical artifacts, but these were often customized to existing (sometimes flawed) business processes and not amenable to easy modification [Brown, 2002]. Some of these problems were alleviated when business and management schools in major institutions began to offer undergraduate MIS programs and concentrations.

MIS CURRICULUM DEVELOPMENT IN US AND CANADIAN UNIVERSITIES

For over 30 years, consortia of US academic institutions, business organizations, and accreditation bodies collaborated to develop curriculum models for undergraduate MIS programs. The initial undertaking was conducted in 1972 by the Association for Computing Machinery (ACM), an organization with both academic and professional members, [Ashenhurst, 1972] and several other notable efforts were completed between 1973 and 1994 [Nunamaker, Cougar, and Davis, 1982 Turner and Tucker, 1991; Longenecker et al., 1994]. The most comprehensive, collaborative MIS curriculum development effort in the United States and Canada, however, was completed in 1997 by ACM, the Association of Information Systems (AIS), an academic organization, and the Association of Information Technology Professionals (AITP), a professional organization [Davis et al., 1997]. The most recent effort was undertaken in 2003 by a large number of faculty in collaboration with ACM, AIS, and AITP [Gorgone et al., 2003].

The ongoing curriculum development exercise is necessary to maintain the relevance of the content of MIS programs in order to satisfy industry demand for entry-level graduates with good technical and business skills [Gorgone et al., 2003]. These graduates should be able to solve business problems individually and in groups and be equipped to exploit opportunities for rapid progression and career growth. The model curriculum forms the basis for the accreditation of MIS undergraduate programs (Appendix IV). The business component of degrees offered by undergraduate business programs is prescribed by the AACSB.

COMPUTING STUDIES IN OTHER COUNTRIES

The author also researched computing programs in 44 institutions (selected randomly) from ten other countries around the world: Australia, England, Hong Kong, India, Ireland, Israel, Kuwait, New Zealand, Singapore, and South Africa. These countries were selected for a combination of the following reasons:

- As is the case with the English-speaking Caribbean nations, these countries were all former members of the British Empire[1] and with the exception of Israel, Hong Kong, and Kuwait are current or former members of the British Commonwealth[2], a voluntary association of nations that includes Great Britain and its current and former dependencies.
- With the exception of South Africa and India, these countries are considered developed countries; however, all benefit from vibrant IT sectors.
- The majority of these countries had a high network readiness index (NRI) in the 2003-2004 ratings of 102 countries. NRI is a composite rating involving nine factors, which assesses the degree of preparation of a nation to participate in and benefit from information and communications technologies (Dutta and Jain, 2004). Kuwait, however, was not rated and India's score was just above those of Jamaica and Trinidad & Tobago, the only two ESC countries to make the index.

From a Caribbean perspective, the programs in India, Ireland, Israel and Singapore are particularly interesting: These countries provide offshore IS services, which is a goal shared by several ESC countries [Reichgelt, 2001]. India is also a developing country with a low NRI rating. However, it is the leader in offshore IS outsourcing services. Singapore, now well developed, is an exemplar of the model of economic growth that ESC countries aspire to. Singapore, emerged from a colonial experience, obtained independence at about the same time (the early 1960s) as the larger ESC islands.

The study included a representative sample of 44 degree-granting institutions from the 10 countries. All three universities in Singapore were selected, the only qualifying institution from Kuwait, and five universities (chosen randomly) from each of the other counties. While the objective was not to secure statistically definitive conclusions, this sample seemed large enough to accommodate adequate analysis and provide accurate indications of the general nature of computing programs in these countries. The details of CE curricula in these institutions were not analyzed fully because ESC countries offer only a single CE program. The comparison would not be worthwhile.

Understandably, no single philosophy permeated MIS curricula and programs in the countries studied. In some instances, the three major branches of undergraduate computing studies were housed in separate divisions (engineering, sciences, and business); in other cases, a single School of Information Technology was responsible for all three branches, each branch with its

[1] Israel was never a member of the British Empire but came under British mandate between 1920 and 1946
[2] The Republic of Ireland is no longer a member of the British commonwealth

distinct focus. Some of the programs were shorter than those in the US (three instead of four years). A few included more "hands-on" experience than is typical in US institutions, while others were purely theoretical.

No major differences were found in the technology content of these programs in comparison to US programs. Two common themes characterize the curricula of the institutions selected.

1. They mostly offered both CS and MIS programs; however, when one was missing, it was more likely to be CS than MIS.

2. Like the US and Canada, their MIS curricula structures included a reasonable mix of business and organizational knowledge content, which seemed appropriate for preparing students to solve information problems in organizations.

IV. COMPUTING PROGRAMS IN THE ENGLISH-SPEAKING CARIBBEAN

The University of the West Indies (UWI) is the flagship institution in the region; its campuses are in Barbados, Jamaica, and Trinidad & Tobago. UWI is a public institution, which also serves, and is funded by, Antigua and Barbuda; The Bahamas; Dominica; Grenada; Montserrat; St. Kitts and Nevis; St. Lucia; St. Vincent and the Grenadines; and the Turks and Caicos Islands; Belize in Central America; and Guyana, which is located in South America. UWI began its computing curriculum with scientific programming courses within existing natural science programs. It then extended the offering to joint degree programs (e.g., Mathematics and Computer Science) and eventually offered full Computer Science degrees. Eight other conventional university systems exist in the ESC and a few others were excluded from this research for reasons reported below.

- Bermuda College and Barbados Community College (BCC), both of which offer excellent MIS programs, were excluded from this analysis because they only offer associate degrees. However, these colleges could provide useful MIS curriculum models to the larger ESC institutions. Bermuda College offers an excellent business-oriented degree in MIS, and BCC provides a great example of partnering with the business community to establish a business-relevant MIS program.

- The School of Business and Computer Science in Trinidad, whose IS program is delivered remotely by an overseas institution was not included; this article or any other Caribbean-focused discussion is unlikely to influence curriculum decisions in the country where the courses are designed.

- Nontraditional programs at the Commonwealth Open University in the British Virgin Islands and Berne University in St Kitts were excluded; these "on-line" programs either abbreviated matriculation requirements or gave credit for life experiences.

Following is a brief overview of undergraduate degree programs in computing disciplines in all the conventional degree-granting institutions in ESC countries.

THE BAHAMAS

The College of the Bahamas offers the BBA degree in Computer Information Systems. The program includes an admirable mix of technical, business, and general education courses, which seem adequate to deliver the educational breadth to prepare students satisfactorily for positions as solution providers in business organizations.

BARBADOS

At UWI's Cave Hill campus it is possible to pursue CS studies with a Management minor as well as the specific combination of IT and Management, although it was not clear (from the information obtained) what constituted the IT component of the offering. The Department of Management Studies offers a variety of minors with its Management degree, but CS is not one of them.

JAMAICA

The department of Management Studies at UWI, Mona offers an excellent Masters program in MIS, but no undergraduate MIS concentration. UWI's large CS program in the Faculty of Natural Sciences offers minors in several areas.

The School of Computing and Information Technology of the University Technology (UT) is in the Faculty of Engineering and Computing. It does not offer MIS programs in the Business School. By and large, the two MIS-like undergraduate degree courses that UT offers are techno-centric: The Bachelors degree in computing and information technology (CIT) is probably too technical to be considered an authentic MIS program; the Bachelor of computing with management studies (CMS) combines CS and management studies to equip students with management skills to fill managerial positions in the computing industry. The latter is offered to graduates who already hold the diploma in Computer Studies.

Northern Caribbean University's (NCU) College of Business and Information Science contains three departments--Business Administration, Management, and Information Science. A MIS concentration is not offered in the business or management programs. However, the degree in Information Science contains enough business emphasis to be classified as an MIS program. The Information Science title may be somewhat misleading: it is now the preferred name for older library science programs, but in some cases it is used to describe combined management science (or decision sciences) and Management information systems departments. This is not the intention at NCU, however.

TRINIDAD AND TOBAGO

UWI, St. Augustine[3] offers an MIS minor in its management studies degree, which is an improvement over the arrangements in corresponding departments at its sister campuses, but is still deficient in providing the requisite blend of skills obtainable from the coupling of IT and business studies reinforced with appropriate business examples and projects.

Caribbean Union College offers a CS program, which it rounds off with a business minor, but it does not seem to go far enough in incorporating non-technical subject matter.

THE US VIRGIN ISLANDS

The University of the Virgin Islands (UVI) (in the US Virgin Islands) consists of two campuses, one in St. Croix and the other in St. Thomas. It prepares students for both the local and US job markets. Its operations are similar to US institutions and it is accredited by one of the six regional US accreditation bodies. The computing programs at UVI are structured similarly to those in universities and colleges in the US. It offers a CS degree in the Science and Math Division and the MIS concentration in its Bachelors program in the Business Division.

OTHER ENGLISH-SPEAKING CARIBBEAN COUNTRIES

- The University of Guyana[4] contains CS and business and management studies departments, but these programs are not related.

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[3] The St Augustine campus houses the engineering school for UWI; only one of two in the region and the only CE program in the ESC

[4] Guyana though physically located on the South American Continent is one of the countries that funds UWI. It is always featured in collaborative ventures among Caribbean nations, and like Belize, is a member of the Caribbean community and common market (CARICOM) which promotes economic integration among member states and is in the process of establishing a single market and promoting free movement of labor among member nations.

- The newly created University of Belize chose to offer the more popular (in the Caribbean) CS degree in the Faculty of Engineering and Information Technology but has no MIS program.
- The International College of the Cayman Islands (ICCI), which was founded in 1970, offers Bachelor of Science degrees in business administration (with majors in Accounting and International Finance). It has no MIS offering, which is surprising for a new institution operating in a country whose distinctive competence is in the information-intensive areas of banking and financial business services.

V. CONCLUSIONS

The examination of the undergraduate computing curricula in ESC institutions supports the contention that these programs are skewed toward CS, without adequate coverage of MIS. Nine of the 11 institutions offer computer science degrees but the paucity of MIS programs in their business schools and management departments (as summarized in Table 2) is glaring. The smattering of individual MIS-type courses in many of these institutions suggests some awareness of the importance of these subjects. However, current IT curricula structure and balance do not demonstrate an acceptance of the notion, embraced by most major U.S. institutions, that a comprehensive MIS program is an essential, value-added offering to the business community

Table 2. English-speaking Caribbean Universities

Country	Degree Granting Institutions	Computing Programs	Comments
Bahamas	College of the Bahamas	MIS	Exemplary program
Barbados	UWI - Cave Hill	CS	
Belize	University of Belize	CS	
Cayman Islands	ICCI	CS	
Guyana	University of Guyana	CS	
Jamaica	UWI – Mona	CS	Graduate MIS program
	University of Technology	CS, MIS	The MIS program is not in the Business School and requires more business content
	Northern Caribbean University	MIS	Called Information Science
Trinidad &Tobago	UWI - St. Augustine	CE, CS	
	Caribbean Union College	CS	
US Virgin Islands	UVI	CS, MIS	US-directed institution; many graduates placed in the US

It is paradoxical that CS is the dominant branch of computing studies in these institutions that operate in a region that hardly create IT; the overwhelming majority of their graduates are employed by IS departments in business organizations as “appliers” of IT. From most accounts, these graduates customarily excel in early job assignments involving tasks well-suited to their technical education. However, their effectiveness gradually diminishes as they move progressively into positions in which business analysis and interpersonal relationship skills became more critical. Professional growth and potential contribution are hampered by limited preparation and the slow acquisition of requisite business and people skills that need to be gained experientially on specific projects or by partnering with domain experts.

The designers of computing curricula in ESC institutions attempt to satisfy the need to couple IT and business studies by providing cross-disciplinary combinations of majors and minors. This approach does not solve the problem. A basic assumption of MIS programs is that, for major portions of their careers, graduates will establish organizational systems and manage IS resources. The challenge of teaching MIS concepts is to ground learning exercises and project experiences in problem-solving examples within business contexts. CS graduates are prepared more for technology development than for human interaction and collaborative work. CS majors with minors in business disciplines may not be provided enough opportunity to develop the culture of collaboration and peer learning that is required to reinforce the concepts studied in practical projects alongside students in their own discipline [Granger and Lippert, 1999].

Technological adroitness is both desirable and extremely useful, but especially in the increasingly threatening environment of global competitiveness, Caribbean businesses can scarcely afford capital outlays to fund costly technological experimentation. This consideration accentuates the need for MIS programs (associated with business schools) to supply IT graduates who can help organizations identify suitable technology adoption and deployment strategies that are optimized to the peculiarities of their respective business requirements. The study and assimilation of knowledge about the power of IT (in and of itself) undershoots the real target (at least in this part of the world) of its application to the solution of information problems in organizations.

VI. RECOMMENDATIONS

Tertiary institutions in the ESC should seek to emulate the approach to computing studies adopted by U.S. and other institutions elsewhere who compartmentalize their programs into Computer engineering, computer science, and MIS and formulated appropriate objectives and models for curricula development in each area. Because of resource limitations, ESC universities, perhaps more than their counterparts in the developed world, need to plan strategies for developing computing programs that better reflect the demand for graduates in each of those branches. On this basis, it seems that a significant reallocation of resources is necessary to adjust the current imbalance in CS/MIS programs in light of the mismatch of supply and demand.

The focus of ESC institutions is on supplying technically oriented CS graduates; ESC business organizations demand MIS graduates capable of assimilating the socio-technical dimensions of IS delivery. This anomaly should be addressed quickly or ESC countries will continue to experience ill effects of the IS crisis. On the demand side of the region's IS ambitions, the lack of focus on MIS could mean ineffective IS. On the supply side, these countries may continue to have little impact on the offshore IS market.

In general, MIS programs should be associated with business schools. These schools are better able to satisfy the requirements for preparing students to assume responsibilities as solution providers in organizations. The design of curricula for such programs should be undertaken collaboratively with the business community. It would also be helpful if such programs could accommodate real-life projects rooted in real business examples for real clients. This approach would allow accelerated exposure to IS application development in context; incorporating people and organizational issues, project risks, and communication structures.

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APPENDIX I. Typical CE Curriculum

Knowledge Area	Description	Subject Matter
Algorithms and Complexity	Machine-implementable procedures for solving computational problems	Basic algorithmic analysis, Computing algorithms, Distributed algorithms, Algorithmic complexity
Computer Architecture and Organization	Hardware components, organization and performance and characteristics of computing devices	Fundamentals of computer architecture, Computer arithmetic, Memory system organization and architecture, Interfacing and communication, Processor systems design, CPU organization, Organization of the CPU,
Computer Control & Robotics	Automated manipulations to replace human rotor functions in 3-D	Discrete-time and quantized data control systems, Z-transform and state space, digital controllers and components, industrial and robotic systems, 3D space, geometry of robotics manipulators., transducers and interfacing
Computer Systems Engineering; Software Engineering	Methods of coordinating and controlling hardware and software systems resources during engineering	Life cycle, design, construction, testing, maintenance, specialized systems, reliability, language translation, validation, software tools and methods, project management
Circuits and Signals	Schemes for connecting geographically dispersed computing devices	Electrical quantities, resistive and reactive circuits, frequency response, Fourier and Laplace transforms, filters
Digital Logic; Digital Signal Processing	Basic physics of digital circuits and the design of combinatorial and sequential logic and the study of discrete-time linear systems.	Switching theory, logic circuits, digital systems design, modeling & simulation, discrete time signals, digital spectra analysis, discrete Fourier transforms
Electronics/ Instrumentation	Elements of electrical and electronic circuits, devices, and their characteristics	Diode circuits, Voltage & current circuits and sources, storage elements, MOS logic families, transistors, diodes, capacitors, inductors

Embedded Systems	Automated processing capabilities resident in operational equipment	Embedded microcontrollers, multiprocessors, and programs, real-time operating systems
Computer Networks	Digital networks for linking computing devices	Network architecture, protocols, client-server, data security and integrity, data communications, compression
Operating Systems	Systems that control computing machines and cause them to do work	Design principles, concurrency, scheduling & dispatch, memory & device management, performance
VLSI/ ASIC Design and Fabrication	Fabrication processes for very large scale integrated circuits	Electronic properties of materials, inverter structure, combinational & sequential logic structures, semiconductor & alternative circuit structures

Source: [Aspnes, 1994; Demming et al., 2002; Soldan et al., 2004; Valero-García, 1999]

APPENDIX II. TYPICAL CS CURRICULUM

Knowledge Area	Description	Subject Matter
Algorithms and Data Structures	Machine-implementable procedures for solving problems	Arrays, dynamic programming, combinatorial optimization, cryptography
Architecture	Hardware and software components and how they are organized into systems	Von Neumann model; instruction set; pipelining; cache and virtual memory superscalar architectures; supercomputing; multithreading; parallel processing
Artificial Intelligence	Branch of study concerned with getting machines to replicate human symbolic reasoning	Knowledge replication, knowledge representation, natural language processing, neural networks, expert systems, genetic algorithms, fuzzy logic
Communication Networks	Schemes for connecting geographically dispersed computing devices	Communications media, network architecture, distributed computing, network topology, protocols
Computational Science	Using Mathematics and computer science in the analysis of numerical algorithms to solve scientific or engineering problems	Number theory and numerical methods, linear algebra, Fourier transform, mathematical modeling
Data Management	Organization and control of persistent data sets that are shared	Data modeling, access methods, normalization, data security and integrity, query languages for data manipulation and control
Discrete Structures	Models of computational spaces which provide the mathematical foundations for several computer science courses	Functions, relations, sets, Boolean algebra, propositional logic, digital logic, number theory, the fundamentals of counting
Graphics and Multimedia	Visually representing physical and conceptual objects and integrating data presentation formats	Multimedia objects, hypermedia, digitization, visualization, animation, virtual reality
Interfaces	Mechanisms for facilitating communication between humans and computers, and among independent systems	User, software, hardware interface design, usability engineering, haptics, ergonomics

Operating Systems	System software that provides the services for coordinating computing resources	Kernel technology, memory management, performance monitoring, device control
Programming	Designing and generating symbolic codes that use algorithms and data structures to solve problems	Functional, logic, concurrency, programming paradigms, formal semantics
Programming Languages	Notations and symbols that specify the vocabulary syntax rules for instructing computers to perform specific tasks	Compilers, COBOL, C++, Java
Software Engineering	The application of engineering to the evolution of large software systems	Requirements specification, software design, construction, deployment, life cycle methods, quality assurance
System measurement	Measuring and analyzing system and network performances	Queuing theory, simulation, workload modeling,

Source: [Cross et al., 2001; Demming et al., 2002]

APPENDIX III. MIS KNOWLEDGE CONTENT

Knowledge Area	Description	Subject Matter
Personal productivity Tools	Prerequisite knowledge for the effective assimilation of the major areas	Spreadsheets, databases, presentation graphics, web authoring
IS fundamentals	Introduction to the field of information systems, its organizational role and its relationship with information technology	IS terminology; systems concepts; systems delivery methods; IS architecture; IS professional and careers;
IS theory and practice	Theories and concepts that describe the motivation for IS methods and practices	Systems, organization and management theory; information quality, decision-making; relationship of corporate strategy and planning, to IS strategy and planning; object orientation; ethical, and social impacts; evolution of IS facilities; change management
IS development	Analyze organizational data and information problems and design and deploy supportable IS solutions	Life cycle phases; requirements determination; IS process management; software engineering principles, systems analysis and design, systems lifecycle management methods;
IS resources management	Manage the human and technical resources to deliver and sustain IS processing	Information security and quality, legal, systems integration, project management, disaster planning and recovery; evaluation of systems performance, feasibility assessment
Information Technology	Providing breadth and depth in the technical elements of the discipline including installation, configuration and operation	Hardware and system software; programming, data, file and object structures; networks and telecommunications concepts, configuration and management
E-business strategy, architecture, and design	Introduction to the peculiar IS considerations required for e-business operations in national and global contexts	Business models, supply chain management; design of solutions for Internet, intranets, extranets; EDI; enterprise application interface systems concepts; payment, security, trust issues

Source: [Burkett, 2002; Demming et al., 2002; Gorgone et al., 2002; Ives, B. et al., 2002; Noll and Wilkins, 2002]

APPENDIX IV. ACCREDITATION OF COMPUTING PROGRAMS[5]

The evaluation for accreditation is a voluntary process for colleges and universities. The objective is to inspire public confidence in the quality of institution's educational process and product. Accreditation is granted if the institution (or a program) meets and exceeds criteria of educational quality pre-established by an independent accreditation body, which is typically either a non-profit organization or government sponsored body established for that purpose. Accreditation bodies in the U.S. are recognized by both the Department of Education and the Council for Higher Education and includes institutional accreditation (the entire institution is accredited) and program accreditation (a single program). In addition to 6 regional bodies that cover institutions in particular geographic locations, there are over 75 national and specialized accreditation boards. The accreditation process helps participants improve the quality of their institution and programs and its conferral indicates that the accredited institution or program adheres to high quality standards with respect to curriculum, faculty resources, admissions, degree requirement, library and computer facilities, financial resources, and other criteria and is capable of providing an effective educational product. The accreditation of computing studies is controlled by several bodies, and different arrangements apply in different countries.

Table A-1 Computing Accreditation in the U.S.

Branch of Study	Accreditation Body	Further Reference
Computer Engineering	The Accreditation Board for Engineering and Technology (ABET)	www.abet.org
Computer Science	Computing Sciences Accreditation Board (CSAB)	www.csab.org
Management Information Systems	ABET/CBET recently approved accreditation criteria specifically for MIS	
Business	The International Association for Management Education, formerly American Assembly of Collegiate Schools of Business (AACSB)	www.aacsb.edu/accreditation

Table A-2. Computing Accreditation in the Other Countries Studied

Country	Accreditation Body
Canada	The Canadian Engineering Accreditation Board (CEAB) oversees engineering accreditation and the Canadian Information Processing Society (CIPS) other computing programs
Australia	The Institute of Engineers, Australia (IEAust) accredits CS and CE programs
England	The British Computer Society (BCS)
Hong Kong	Hong Kong Council for Academic Accreditation (HKCAA)
India	National Council of Educational Research & Training
Ireland	National Certification Authority
Israel	The Israeli Ministry of Education: The Council for Higher Education
Kuwait	No national body; Evaluated by ABET (CE) and AACSB
New Zealand	New Zealand Qualifications Authority (NZQA)
Singapore	National InfoComm Competency Centre (NICC)
South Africa	Engineering Council of South Africa (ECSA); Legislation passed to establish body similar to NZQA
The English Speaking Caribbean	Accreditation is the responsibility of the various governments, conducted through education ministries or their nominees

[5] Based on Gambill and Maier [1998], Gorgone and Kanabar [2002], and Impagliazzo, J. et al., [1997]

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