

SUPPLY OF INFORMATION  
TECHNOLOGY SPECIALISTS  
AMONG NORTHEAST OHIO'S SYSTEM OF  
HIGHER EDUCATION

Research Prepared for:

**The Higher Education in Economic Development [HEED] Initiative**

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Of the Ohio Urban University Program

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December 11, 2001

# SUPPLY OF IT SPECIALISTS AMONG NORTHEAST OHIO'S SYSTEM OF HIGHER EDUCATION

## KEY OBSERVATIONS

### Alignment of IT Education Programs With IT Classifications of Work:

**Comparing supply of IT workers with market demand is difficult given lack of compatibility between education programs and existing classifications of IT work. Alignment of Northeast Ohio's IT education programs could be improved to the benefit of college entrants, IT graduates, incumbent and future workers, employers and regional economic development activities:**

- A disconnect in language is apparent between educational programs and the array of IT jobs available.
- IT specific education programs are dispersed across a variety of academic disciplines which tend to influence heavily the nature of IT instruction. There is also little consistency in how offerings are titled and organized across institutions of higher education.
- Better alignment is apparent when separate IT divisions/departments have been established within higher education, not only in terms of common language but in the substantive nature of instruction and related job preparation.

### Enrollment in IT Education Programs:

**Enrollment in IT specialty programs among Northeast Ohio institutions of higher education is strong with near 26,000 students enrolled in 2000/01 alone. This means higher education is attracting students to IT programs of study.**

- Enrollment in IT programs is particularly strong at the two-year degree level with approximately 12,750 students in 2000/01 alone (50% of all IT enrollment).
  - Cross-cutting IT programs (where students are trained in a combination of IT specialty areas as IT generalists), Manufacturing Engineering Technologies, and Programming/Systems Analysis comprise the greatest share of associate degree enrollment (82%).
  - An additional 11% are enrolled in Computer Systems Support/Repair and Digital Media Technology.
  - Interestingly, all of the regions enrollment in Software Development programs are at the two-year level.
- Approximately 4,200 students are enrolled in four-year degree programs (16% of all enrollment) with the greatest share in more traditional Computer Science programs (most comparable with Programming/Systems Analysis related IT work).
- When advanced degrees are combined (bachelor, master, and Ph.D.), enrollment in associate degree IT programs is still higher. Approximately 11,400 students were enrolled in advanced degree programs in 2000/01. Kent State University takes credit for half of all enrollment at the advanced degree level.

- Non-credit and certificate programs comprised 6% of all IT enrollment. However, this data is not tracked by all institutions and was only reported by a few colleges and universities.

### Production of IT Specialists (Graduates of IT Programs):

**Production of degreed IT specialists is much weaker than what is portrayed by enrollment data. In academic year 2000/01, approximately 1,750 IT specialists graduated from Northeast Ohio's system of higher education.**

- Overall production of IT specialists is strongest in Programming/Systems Analysis (37% of all graduates), Manufacturing Engineering Technologies (21% of all graduates), Digital Media Technology (13% of all graduates), and Cross-Cutting (IT Generalist programs at 12%).
- While enrollment is highest at the associate degree level, production of IT specialists is highest at the baccalaureate level (48% of all IT graduates). This is common given the disproportionate share of part-time students and place-bound adults served by the two-year system.

### Supply of IT Workers Compared With Market Demand:

**According to this analysis and a regional employer survey conducted by the Greater Cleveland Growth Association, demand for IT specialists is far greater than our supply of new, degreed workers. By IT cluster, the following is evident:**

- Northeast Ohio's supply of new IT graduates is adequate in Digital Media Technology (222 graduates in 2000/01 compared with 148 job vacancies).
- Gaps between supply and demand are notable in the IT clusters of:
  - Systems Development & Integration: Programming/Systems Analysis Emphasis (2,452 job vacancies and 651 graduates);
  - Networking Technology (744 job vacancies and 34 graduates);
  - Information Systems Management (584 openings and 67 graduates);
  - Software Development/Engineering (435 openings and 5 graduates); and
  - Computer Systems Support/Maintenance/Repair (1,801 openings compared with 46 graduates).
- No degree programs are offered in Database Administration and Technical Sales, two areas of great demand in Northeast Ohio.

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**According to other sources of information, demand for IT workers must be considered by size and nature of employer:**

- Within the IT industry, and among non-IT large employers who are IT dependent, there tends to be greater demand for Programmers/System Analysts and Software Developers/Engineers.
- In small to medium sized non-IT firms, demand is greater for Systems Support/Repair/Maintenance personnel, Networking Specialists, and Digital Media Specialists.
- In fact, the Information Technology Association of America reports that 70% of all new IT jobs will be created among firms with 50-99 employees, primarily in the Systems Support and Networking clusters.
- For Northeast Ohio, our ability to supply non-IT small to medium sized firms is greatly lacking (with large gaps in our production of Systems Support and Networking personnel).

- While our greatest strength is in the supply of Programmers and Systems Analysts, an area of IT work critical to the IT industry and large non-IT employers, there is also a sizeable gap between supply and demand in this area as well. Even greater is the gap in our production of Software Development and Engineering personnel. Because workforce development is a vital economic development strategy, closing these gaps could enhance our ability to retain and attract the IT industry and large non-IT employers.

**Integration of IT learning across non-IT academic disciplines is strongest in Education programs.**

## I. PROJECT RATIONALE, RESEARCH APPROACHES & ANALYSIS FRAMEWORK

### **Project Rationale**

A region's ability to compete in the global economy is highly contingent on the quality of its workforce. As technology becomes an important pre-requisite for global competition, so does an adequate supply of Information Technology specialists and a workforce that is technologically competent across all industry sectors and occupations. Not only is the supply of IT specialists and enabled workers important to overall productivity and competitiveness of our existing economic base, it is crucial if our region is to successfully attract and retain IT establishments and other large companies who are increasingly IT dependent.

In recent years, many partnerships have been established within Northeast Ohio to improve linkages between private and public sectors and to enhance the quantity and quality of IT workers for the benefit of employers and individual job seekers/workers alike. These include partnerships like the *Northeast Ohio Software Association* and the *Northeast Ohio IT Skills Alliance*. In addition to public/private partnerships, some research has been done to assess regional IT demand. The *Greater Cleveland Growth Association*, for example, recently completed an employer assessment which identified IT staffing needs of Northeast Ohio. Staff at *Cuyahoga Community College* have "examined the educational resources that Northeast Ohio can call upon to meet the demand for these highly skilled workers". And, the *Joint Center for Policy Research of Lorain County Community College* conducted an action research project for the *Ohio Board of Regent's EnterpriseOhio Network* to look at key IT human resource needs among Ohio employers as well as capacity of the states two-year system of higher education in meeting those needs and demands.

While a base of information exists relative to IT demands, little has been done to assess the contributions of our regions system of higher education relative to the supply of IT workers in Northeast Ohio, and most importantly, how current supply compares with employer demand. In response, a research team comprised of representatives from Cleveland State University's Urban Center, the Greater Cleveland Growth Association, Cuyahoga Community College, and Lorain County Community College's Joint Center for Policy Research was convened in January 2001 to develop a research plan for assessing the production of IT specialists and enabled workers. The intent of the research was to conduct a system level, capacity inventory based on enrollment and production of IT graduates among the public and private colleges and universities in the region. In doing so, it was envisioned that potential gaps between supply and demand could be determined and service delivery opportunities identified for institutions of higher education.

While numerous types of education and training providers impact the supply chain, this project is sponsored by Higher Education in Economic Development (HEED) which is a partnership of the Northeast Ohio Council on Higher Education and the Regional Workforce Partnership. This study has been limited to

the production of IT specialists by the 22 colleges and universities in Northeast Ohio and does not include post-secondary education and training providers like the adult education divisions of the regions Career Centers (i.e., Joint Vocational Districts).

In addition to production of IT specialists, there was an interest in determining the extent to which colleges/universities are producing IT enabled workers across academic disciplines. An assessment of the kind of IT courses embedded in non-IT academic disciplines was performed by the research team to assess the production of a technologically competent workforce beyond IT specialty.

### **Research Approaches**

While secondary data sources are available like the *National Center for Education Statistics* and the state of *Ohio HEI system*, the research team decided that primary data collection was necessary to satisfy project goals and objectives. First, given its' expedient evolution, there is no consistent framework or common language from which IT is defined or measured within the private sector and there is even less compatibility with education/training program terminology in relation to marketplace demand. This is further complicated by the fact that education/training programs are dispersed across academic disciplines and cannot be found within one academic college or department. Second, secondary sources of data provide no depth on the substance of education/training programs and it is impossible to infer the nature of these offerings by program or degree title alone. In addition, measures of output (enrollment/graduates) from secondary sources are typically outdated by the time of their release.

Three overall phases of primary data collection were executed. Phase I consisted of a college/university catalog review to identify IT specialty programs offered by each institution. Once identified, each program was logged in a spreadsheet which was converted to a questionnaire format. In Phase II, the spreadsheet/questionnaire was forwarded to offices of Institutional Planning and Research. Each institution was asked to verify their IT specialty programs and provide detailed information on enrollment and graduation patterns for the 2000/01 academic year. Phase III consisted of an additional catalog review to identify IT related courses of study embedded in non-IT academic programs. In other words, Phases I and II of the research effort concentrated on IT programs to assess production of IT specialists in Northeast Ohio. Phase III, on the other hand, focused on IT course requirements in all other program areas to determine what is being done to produce technologically competent workers in non-IT specialty areas.

Initial response to data requests was achieved from 14 of the 22 colleges/universities in the region. This past summer, a letter was sent by the co-chairs of HEED to the remaining institutional presidents which produced another 5 responses. Two of the institutions indicated they did not offer any IT programs. Despite repeated attempts to secure participation in the study, only one institution declined to respond. The 21 of the regions 22 institutions responding to the study included:

Baldwin Wallace College  
 Case Western Reserve University  
 Cleveland College of Jewish Studies  
 Cleveland Institute of Art  
 Cleveland Institute of Music  
 Cleveland State University  
 Cuyahoga Community College  
 David N. Myers College  
 Hiram College  
 John Carrol University  
 Kent State University  
 Lake Erie College  
 Lakeland Community College  
 Lorain County Community College  
 Malone College  
 Notre Dame College of Ohio  
 Stark State College of Technology  
 Oberlin College  
 The University of Akron  
 Ursuline College  
 Youngstown State University

## Analysis Framework

To effectively conduct an analysis of IT supply, it was important to look at the nature of IT production among Northeast Ohio's system of higher education in relation to IT work. Given that there is no consistent framework or common language from which IT is defined or measured, an analysis framework was adopted similar to what was used by the Joint Center for Policy Research in conducting IT research for the *Ohio Board of Regents EnterpriseOhio Network*. This framework was established after one and half years of careful IT research at national and state levels. The framework also has comparability with IT clusters defined by the *Information Technology Association of America* and national IT skill standards developed by the *Northwest Center for Emerging Technologies* at Bellevue Community College. At the state level, there is also comparability to the *itWORKS.OHIO* framework developed under the auspices of the Joint Council of the Ohio Board of Regents and the State Board of Education.

While it is difficult to identify succinct categories of IT specialty by nature of work, the following IT career clusters served as the analysis framework for this study:

PRIMARY IT CLUSTER	DEFINITION OF WORK	RELATED JOBS
<b>Computer Support, Maintenance, Repair</b>	Provides customer and technical support through analysis and problem solving to facilitate installation, maintenance, education, and documentation of a variety of technologies (Northwest Center for Emerging Technologies)	Computer Operations Manager & Supervisors, Computer Operations Technician, Technician Specialists, Technical Support Engineers, Help Desk Technicians, PC Technicians, Support Specialists, Customer Service Reps.
<b>Network Specialists</b>	Analyzes, operates, administers, maintains, tests, and implements the network interconnections of devices, systems, and/or communication services to meet functional objectives of the business (Northwest Center for Emerging Technologies)	Manager, Voice & Data Communications, LAN/WAN Managers, Intranet Managers, Communications Specialists & Analysts, Network Specialists, Network Technicians, Network Security Managers & Specialists.
<b>Digital Media Technology</b>	Creates, designs, develops and produces digital media products which integrates any combination of audio, video, graphics, text, and animation (Northwest Center for Emerging Technologies)	Creative Director, Webmaster, User Interface Designers, Animator, Imaging, Audio Visual Specialists, Multi-Media Programmers & Technicians, Graphic Designers, Content Development Specialists, On-line/Script Writers, Artists 2D/3D, Multi-Media Authoring Specialists, Production Assistants.
<b>Systems Development &amp; Integration: Database Development &amp; Administration</b>	Database administrators participate in conceptual, logical data modeling and physical design, database implementation, maintenance, analysis, and support.	Database Managers, Database Developers, Database Modelers, Database Analysts, Repository Architects, Database Administration Associates.
<b>Systems Development &amp; Integration: Programming &amp; System Analysis</b>	Work involving analysis, design, development, testing, implementation and maintenance of computer application systems to meet functional objectives of the business (Northwest Center for Emerging Technologies)	Program & Project Managers, Senior System Analysts, Systems Analysts, Senior Systems Programmers, Programmers, Requirements Engineers, Senior Programmer/Analysts, Programmer/Analysts, System Architects, E-Commerce Managers & Specialists, Security Managers & Specialists, Applications & Test Engineers/Analysts.
<b>Systems Development &amp; Integration: Software Development</b>	Apply general engineering principles and methodologies to software development (Northwest Center for Emerging Technologies)	Software Design Engineers, Software Engineers, Software Developers, Software Quality Assurance Analysts, Software Test Developers, Functional Testers, Test Engineers, Software Applications Engineers.

Even more difficult than establishing an agreed upon framework of IT work for the region is the ability to relate education programs to each of these clusters. A major component of this work included careful examination of program components like academic division offering the program and core class requirements of each IT program. Using this information (not program titles), each IT education program was categorized within a defined IT cluster. Because some educational programs seemed to emphasize learning and achievement in a variety of areas, an IT cross-cutting category was also included.

In addition to the pure IT clusters of work identified above, we found numerous education programs offered by colleges/universities which could not be excluded as IT programs of study, but also did not fit within the established IT framework. As a result, IT educational program classifications were added to the analysis framework. These IT education programs include:

PRIMARY IT CLUSTER	PROGRAM DESCRIPTION
<b>Information Systems Management</b>	Prepares graduates to analyze and manage information, resources and personnel. The emphasis is on applying and managing information to aid individual and organizations in problem solving, strategizing, promoting productivity, and the effective use of resources.
<b>Cross-Cluster Cutting IT Programs</b>	Prepares individuals in a variety of IT specialties including Systems, Maintenance/Repair, Networking, Digital Media, Database Administration, Systems Development & Integration, Software Development, & Information Systems Development.
<b>Office &amp; Microcomputer Technology</b>	Provides systematic foundations that include methodologies & models for conceptualizing the complex dynamics of the office environment & applying them to office information systems design & implementation. It supports work processes & employee performances. Encompasses office automation, end-user computing, information centers, computer-supported work, performance support, Multimedia & executive information systems.
<b>Business Management Technology</b>	Graduates develop expertise in the technical dimension of technology, skills in managing enterprises in which technology plays a key role, and appreciation for the human dimensions of the new business environment. These programs provide a blend of business managing theory with hands-on technology instruction & learning.
<b>Manufacturing Engineering Technologies</b>	This includes CAD, CAM, and Electronic/Electrical Engineering.

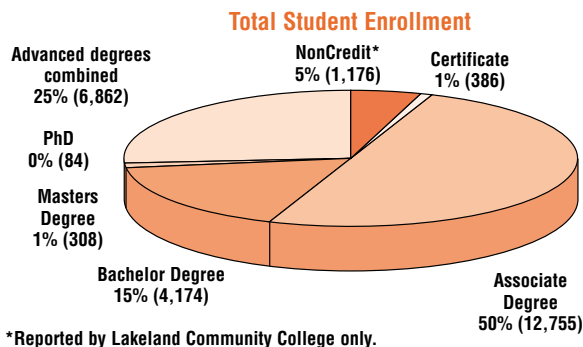
## II. DETAILED FINDINGS PART I: PRODUCTION OF IT SPECIALISTS

### A. IT Student Enrollment

The study revealed that over 25,000 students were enrolled in the 11 Information Technology Specialty programs at Northeast Ohio institutions of higher education. The table below contains a breakdown of student enrollment by award level (i.e, non-credit, certificate, associate's degree, bachelor's degree, master's degree, and Ph D). According to this data the greatest share of the region's enrollment in IT Specialty programs is at the associate degree level. A total of 12,755 students were enrolled in IT associate degree programs which comprised 50 percent of total enrollment in Northeast Ohio. Bachelor degree enrollment constituted 17 percent (4,174 students) while certificates (386) and master degrees (308) made up 1 percent each. When bachelor, master, and Ph D enrollment is combined (11,428 students), there still appears to be a greater number of students enrolled in IT programs at the associate degree level, yet enrollment is more evenly distributed between two year and advanced degree programs. Non-credit enrollment comprised another 5 percent (1,172). However, data for non-credit training were reported by Lakeland Community College only.

TOTAL STUDENT ENROLLMENT BY LEVEL OF AWARD	
Non-credit	1,172
Certificate	386
Associate Degree	12,755
Bachelor Degree	4,174
Masters Degree	308
Ph D	84
*Advanced degrees combined	6,862
<b>Total</b>	<b>25,741</b>

\*This figure represents a combined total of bachelor, master and Ph D degrees from Kent State University

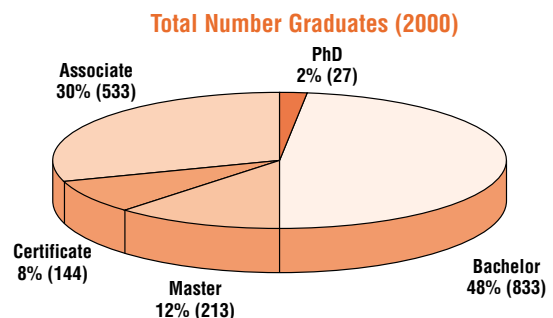


### B. Production of IT Graduates

While IT enrollment appears to be highest at associate degree level, production of graduates within IT specialty in the region is more evenly distributed by award level. In a given academic year, it appears as if the region's system of higher education is producing near 1,800 IT specialists according to 2000/2001 data reported. Nearly one-half of IT students (48%) graduated with a bachelor degree while those with an associate degree comprised one-third (30%) of all graduates. Over 10 percent obtained higher degrees (12% masters degree, and 2% Ph D). When all advanced degrees (i.e, bachelor, master, Ph. D) are combined, the region is producing more IT specialists at four year levels and beyond than it is at the associate degree level. This is a common finding given the disproportionate share of part-time students and place-bound adults served by two-year institutions. Certificate recipients constituted less than 10 percent of all graduates.

2000 GRADUATES TOTALS BY LEVEL OF AWARD	
Non-credit *	0
Certificate	144
Associate Degree	533
Bachelor Degree	833
Masters Degree	213
Ph D	27
<b>Total</b>	<b>1,750</b>

\* None of the institutions reported data for graduates in non-credit programs



**C. IT Enrollment and Graduation by IT Specialty Cluster**

In Northeast Ohio, it appears as if the greatest number of IT specialists are being produced in Programming & Systems Analysis with over 600 graduates in 2000/01. Output also appears to be somewhat strong from Manufacturing Engineering Technologies, Digital Media Technology, Cross-Cutting IT Programs, and Office Microcomputer Technology with over 100 workers produced annually. Enrollment patterns seem to follow graduation patterns. Assuming students successfully graduate from the IT programs, future production is likely to be highest in the same areas we are currently producing the greatest number of workers (i.e., Programming & Systems Analysis, Manufacturing Engineering Technology, Cross-Cutting Programs, and Digital Media Technology). The only IT Cluster that appears to have much greater enrollment than what was produced in 2000/01 is Computer Systems Support, Maintenance, & Repair. While in 2000/01 there were only 46 graduates, enrollment was at 712 students. Either these constitute newer educational programs or graduation rates are low within this particular cluster (all of which are offered at the two-year level and are more likely to comprise part-time students and place-bound adults).

Key areas of IT specialty that may require attention among the system of higher education are Software Development and Database Administration where enrollment and number of graduates are low. Survey results also reveal a dismal picture of worker production in other areas of IT specialty including Computer Systems Support, Maintenance, Repair and Networking Technology.

	Enrollment Totals		2000-2001 Graduate Totals	
	#	%	#	%
Systems Development & Integration: Programming & Systems Analysis	10,933	44%	651	37%
Manufacturing Engineering Technology	2,795	11%	372	21%
Digital Media Technology	1,317	5%	222	13%
Cross-Cutting IT Programs	7,537	31%	215	12%
Office & Microcomputer Technology	373	2%	109	6%
Information Systems Management	367	2%	67	4%
Computer Systems Support, Maintenance, Repair	674	3%	46	3%
Networking Technology	315	1%	34	2%
Business Management Technology	70	.3%	29	2%
Software Development	188	1%	5	.3%
Database Administration	0	0	0	0
<b>Total</b>	<b>24,569*</b>	<b>100%</b>	<b>1,750</b>	<b>100%</b>

\* Total does not include non-credit enrollment.

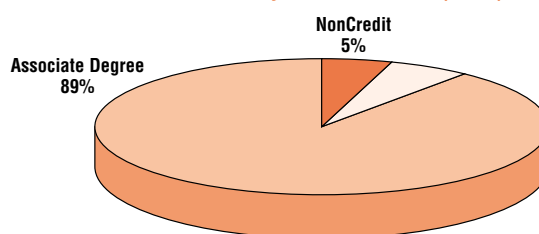
## D. IT Enrollment and Graduation: Individual Cluster Analysis

### COMPUTER SYSTEMS SUPPORT, MAINTENANCE, REPAIR

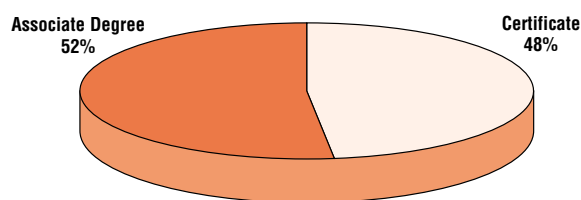
Computer Systems Support, Maintenance, Repair		
	2000 Enrollment	2000 Graduates
Non Credit	38	
Certificate	43	22
Associate Degree	631	24
Bachelor Degree		
Master Degree		
Ph D		
<b>Total</b>	<b>712</b>	<b>46</b>

- All Computer Systems Support, Maintenance, Repair degree programs are offered at the associate degree level.
- While enrollment is strong, the production of graduates in this cluster is low.
- Only 24 Computer Systems Support Maintenance, Repair degreed specialists were produced in 2000/01.

Computer Systems Support, Maintenance, Repair: Enrollment by Level of Award (2000)



Computer Systems Support, Maintenance, Repair: Graduates by Level of Award (2000)



These programs are intended to produce IT supporters who engage in the delivery, installation, operation, maintenance and/or repair of information technology artifacts. They prepare students to understand the design of PC systems including hardware and software needed to run personal computers, minicomputers, and networked computers. Most programs prepare learners for the industry Standard A+ Certification test. Program terminology ranges from Computer Maintenance/Repair Option, "Systems Support," Software Support," to Electronics Engineering with Computer Maintenance/ Repair Option," "Computer Technician," and PC "Support" or "Administrator."

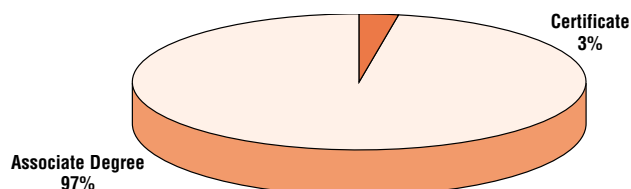
Institution Name	Program Name	Core Courses	Department /Division	Award Level
Lakeland Community College	Computer Engineering Technology	Assembling, Upgrading & Repairing Personal Computers Programming for Science & Technology Visual Basic for Industrial Control Cisco Networking Technology Advanced Assembly & Repair of Personal computers Computer Data Communications Telecommunications Principles	Engineering Technologies	AAS/Cert
Lakeland Community College	PC Troubleshooting			None Credit
Lorain County Community College	Electronic Engineering Technology – Computer Maintenance & Networking Major	Analog & Digital Data Communications Advanced Computer & Printer Diagnostics & Repair Microcontrollers	Engineering Technology	Certificate
Lorain County Community College	Automated Engineering Technologies-Maintenance/Repair Major	Robotics & Automated Manufacturing Programmable Logic Controllers Fabrication Processes for Electronics Workcell Interfacing Electronic Devices	Engineering Technology	AAS
Lorain County Community College	Computer Maintenance & Networking – Certificate of Proficiency	Advanced Computer & Printer Diagnostics & Repair Electrical Circuits	Engineering Technology	Certificate of Proficiency (CP)
The University of Akron	Computer Maintenance & Networking	Operating Systems Network Concepts Microsoft Networking Digital Fundamentals Cisco Networking	Community & Technical College	AAS

## NETWORKING TECHNOLOGY

- Similar to Computer Support Maintenance, Repair, all Networking Technology degree programs are offered at the associate degree level.
- Enrollment is somewhat lower than the Computer Systems Support cluster, but strong.
- However, the production of Networking specialists has been low with only 34 degreed Networking specialists produced in 2000/01.

Networking Technology		
	2000 Enrollment	2000 Graduates
Non Credit		
Certificate	8	0
Associate Degree	307	34
Bachelor Degree		
Master Degree		
Ph D		
Total	315	34

Networking Technology: Enrollment by Level of Award (2000)



*These programs prepare IT workers to utilize latest technologies for network design, administration, operation, maintenance, analysis and applications to business processes. Some programs build upon the computer systems support, maintenance, repair programs with specialty in networking. Some are taught from a business perspective with curriculum in management principles, accounting database processing, basic computer programming, etc. Others are taught from a more technical electronic engineering perspective. Some programs are also tailored specifically to the telecommunications industry.*

Institution Name	Program Name	Core Courses	Department /Division	Award Level
Cuyahoga Community College	Electrical/Electronic Engineering – Telecommunications	Computer Applications & Programming Digital Circuits/Microprocessor I, II & III Telecommunication Design Project	Engineering Technologies	AAS
Lorain County Community College	Computer Information Systems Network Communications Technology	Microcomputer Applications Operating System Interfaces Local Area Networks Database Design & Implementation Program Development Using Visual Basic Network Integration & Management Systems Development Multimedia Fundamentals	Division of Business	AAB
Stark State College of Technology	Computer Networking & Telecommunications	DC Circuit Analysis AC Circuit Analysis PC Upgrading & Maintenance MS Windows 2000 Professional, Server, & Network Infrastructure Microsoft SQL Server Introduction to Computer Networking Implementing & Administering MS Windows 2000 Directory Services Designing an MS Windows Directory/Network Services Infrastructure Designing a Secure MS Windows 2000 Network UNIX Operating Environment Internet/Intranet Software Design Applications Web Server Administration UNIX System Administration	Engineering	AAS
Ursuline College	Computer Networking Certificate	Local Area Network Wide Area Network TCP/IP	Professional Studies	Certificate

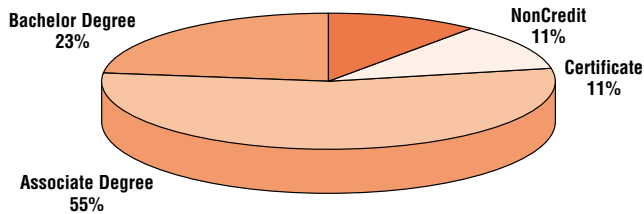
## DIGITAL MEDIA TECHNOLOGY

Unlike Computer Support & Networking clusters, Digital Media programs are offered at both associate and bachelor degree levels.

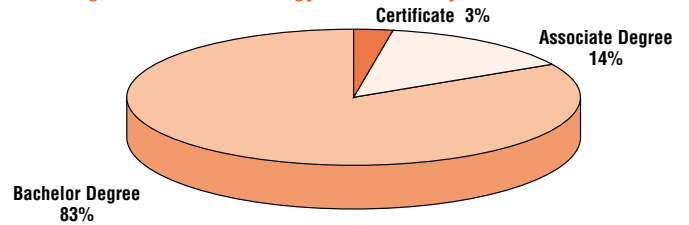
- Enrollment is very strong at the associate degree level and moderate at the baccalaureate level.
- However, the greatest production of Digital Media specialists is occurring at the bachelor degree level.
- Production of Digital Media specialists is much stronger overall than it is for Computer Systems Support & Networking clusters. A total of 216 degreed workers were produced in 2000/01 alone (compared to only 24 and 34 within specialties in Systems Support and Networking respectively).

Digital Media Technology		
	2000 Enrollment	2000 Graduates
Non Credit	164	
Certificate	162	6
Associate Degree	814	32
Bachelor Degree	341	184
Master Degree		
Ph D		
Total	1,481	222

**Digital Media Technology: Enrollment by Level of Award (2000)**



**Digital Media Technology: Graduates by Level of Award**



*These programs prepare individuals to use technological tools and applications to put text and graphics into appealing documentation and presentation formats. Programs range from specific training in Computer Art, Computer Graphics, and Audio/Video Production to broader based training in Digital Media Technology which typically encompasses a variety of these areas. Also included in this career track are Web Design/Development programs. There is little consistency across NE Ohio in relation to academic divisions offering these programs. Curriculum tends to vary based on the nature of the division with the offering.*

Institution Name	Program Name	Core Courses	Department /Division	Award Level
Cleveland Institute of Art	Graphic Design	Graphic Design Computers Layout Rendering Technology Graphic Design I,II.& III Video Basic Tools Community Graphics	Design	BFA
Cleveland Institute of Art	Illustration	Computer Illustration Layout Rendering Technology Illustration I, II & III Design & Production Video Basic Tool Community Graphics	Design	BFA
Cleveland Institute of Art	Industrial Design	Industrial Design ID Graphics	Design	BFA
Cleveland Institute of Art	Medical Illustrations	Design Intro. Scientific Illustration Medical Illustration Instruct. Design Computer Basics Computer Technology Scientific Illustration Illustration Computers Basic Video Tools	Design	BFA

Institution Name	Program Name	Core Course	Department/Division	Award Level
Cleveland Institute of Art	Technology & Integrated Media Environment (TIME)	Digital Arts (Computer transmuted), Computer generated imagery, including 3-D drawings, models & animation Video, Film, Animation Digital Design, Interactive CD-ROMs, Web sites, real-time transmissions Multimedia Production Digital Crafts (Computer transmuted) Robotic forms and similar electronic mechanisms	Technology & Integrated Media Environment	BFA (Bachelor of Fine Art)
Cleveland Institute of Art	Desktop Publishing		Continuing Education	Certificate
Cleveland Institute of Art	Digital Media		Continuing Education	Certificate
Cleveland Institute of Music	Audio Recording	Recording Studio Maintenance Audio Recording Internship Multitrack Recording Techniques Audio Recording Techniques Advanced Audio Recording Tech	Conservatory	BMus
Cleveland State University	Advertising- Multimedia	Mass Media Processes & Effects Media Writing Communication Technology & Social Change Media Programming & Research Advertising Copy writing & Layout Design	Communication	BA
Cleveland State University	Video/Audio Production	Mass Media Processes & Effects Single Source Video/Audio Production & Editing Audio Production for Radio Multi-source Video Production Media Electronics Advanced Video/Audio Production Advanced Video/Audio Editing	Communication	BA
Cleveland State University	Electronic Journalism	Mass Media Processes & Effects Single Source Video/Audio Prod. & Editing Media Writing Audio Production for Radio Multi-source Video Production Media Electronics Electronic Journalism	Communication	BA
Cleveland State University	Graphic Design	Intro to Macintosh Advanced Raster Imaging Advanced Vector Imaging Advanced Typography & Design Digital Media (Web site Design)	Art	BA
Cleveland State University	Computer Graphics	Intro to Macintosh Advanced Raster-Image Development Advanced Vector Image Development Advanced Typography Intro to Digital Media	Art	Certificate
Cuyahoga Community College	Graphic Design	Intro to Macintosh Advanced Raster-Image Development Advanced Vector Image Development Advanced Typography Intro to Digital Media Art	Art	Certificate
Kent State University	Computer Design & Animation	Advanced CAD CAD: Architecture CAD: Civil Applications Engineering Drawing Computer-Aided Drafting Computer Animation Executive Software	Technology	AAS

Institution Name	Program Name	Core Courses	Department/Division	Award Level
Kent State University	Desktop Publishing			Certificate
Kent State University	New Media			Certificate
Lakeland Community College	Graphic Design	Visual Organization Graphic Design Computer Graphics PM Computer Graphics FH Computer Graphics QX Computer Graphics AI Graphic Production Package Design Illustration	Art & Humanities	AAB
Lakeland Community College	Multimedia Studies	Multimedia Integration (incorporation of audio, video, graphics & content into an interactive computer-based delivery medium) Multimedia Production Multimedia Interface Design Basic Computer Animation Writing for Multimedia	Art & Humanities	Certificate
Malone College	Media Communication	Context of Broadcasting Radio Production Television Production Radio & TV Announcing Applied Radio/Television Electronic Publishing	Department of Communication Arts	B.A
Notre Dame College	Graphic Communication	Basic Design Color & Design Graphic Design I,II,III Intro to Computers News writing Film Studies Presentation Techniques Web Site Design & Development	Art Communications	BA
Notre Dame College	Multimedia	Intro to Graphic Design Basic Design Color & Design Graphic Design I,II,III Intro to Computers Multimedia Development Advanced Multimedia Development	Business/IS	BA
Stark State College of Technology	Interactive Media Technology	Interactive Media (compositing, bit-streaming, MIDI, virtual reality) Graphic Art Design Digital Audio/Video Production & Editing C++ for Gaming Development Product Development & Distribution	Engineering	AAS
The University of Akron	Mass Media Communication	Radio Production Studio Production Broadcast News writing Commercial Electronic Publishing Basic Audio & Video Editing Communication Technology Change Fine & Applied	Arts/Communication	BA

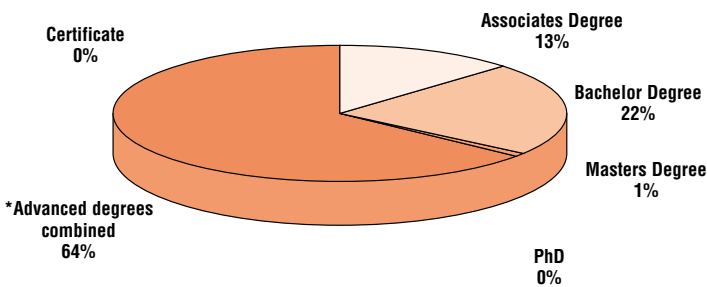
## PROGRAMMING AND SYSTEMS ANALYSIS

A majority of enrollment in the Programming & Systems Analysis cluster is at advanced degree levels (i.e bachelor, master, & Ph D degrees).

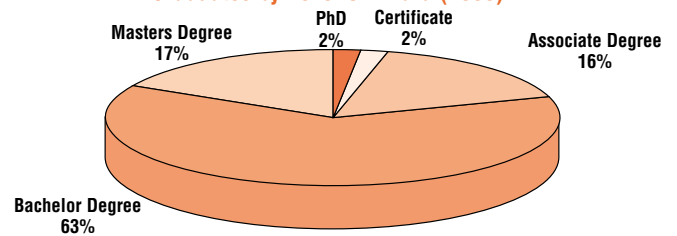
- Both enrollment and production of graduates in this cluster is greatest at the bachelor degree level.
- Overall, the region's production of IT specialists is strongest in the Systems Development & Integration: Programming and Systems Analysis.
- A total of 631 degreed specialists were produced in this cluster in 2000/01 which is about 25 times that of Computer Systems Support and Networking personnel, and 3 times the production of Digital Media specialists.

Systems Development & Integration: Programming & Systems Analysis		
	2000 Enrollment	2000 Graduates
Non Credit		
Certificate	18	10
Associate Degree	1,450	107
Bachelor Degree	2,419	408
Master Degree	145	112
Ph D	39	14
*Advanced degrees combined	6,862	
Total	10,933	651

**Programming and Systems Analysis:  
Enrollment by Level of Award (2000)**



**Programming and Systems Analysis:  
Graduates by Level of Award (2000)**



*These programs prepare individuals to analyze, design, develop, test, implement and maintain computer applications systems (i.e., software including operating systems software systems software and applications software) in accordance with business processes and applications. Generally these programs work with the structure of computer languages and the operation of computer systems. These programs also emphasize translation of problems into logical steps. Heavy emphasis is placed on a wide variety of programming languages (C, C++, COBOL, Pascal, FORTRAN, BASIC, RPG, Assembly Language Programming, etc). Data communications/networks and systems analysis/design are also integral to the learning/instructional process. Some programs are broad based, offering training in a variety of programming areas. Others are more specific. The more traditional computer science programs comprise the majority of these educational offerings.*

Institution Name	Program Name	Core Courses	Department /Division	Award Level
Baldwin Wallace	Computer Info Systems	Programs & Applications Digital Topics Information Systems Introduction to Data Base Systems Building Local Area Networks Systems Analysis & Design	Computer Science	BS Certificate
Case Western Reserve University	Systems & Control Engineering	Fundamental System Concepts Control Engineering Signal Processing Intro to Global Issues Engineering Optimization Engineering Economics & Decision Making	Electrical Engineering & Computer Science	P hD MS BS
Case Western Reserve University	Computer Science	Intro to Data Structures Logic Design & Computer Organization Computer Architecture Systems Programming Intro to Database Systems Programming Language Concepts Software Engineering Intro to Artificial Intelligence Operating Systems	Electrical Engineering & Computer Science	Ph D MS BS

Institution Name	Program Name	Core Course	Department/Division	Award Level
Cleveland State University	Information Systems	Systems Analysis Methods Information Systems in the Organization Modern Database Design & Implementation Systems Development Networks & Telecommunications Object-Oriented Programming for Info Technology Electronic Commerce	College of Business	B.B.A
Cleveland State University	Computer & Info Science	Intro to Programming Data Structures & Algorithms Files & Large Systems Assembly Language Programming PC architecture Operating Systems Database Concepts Structured Systems Analysis Software Engineering Data Communications & Computer Networks Computer Graphics Java Programming Information Technology COBOL Programming Graphical User Interfaces Linear Programming Database Systems & Processing Artificial Intelligence	College of Business	MA B A
Cuyahoga Community College	Computer Studies	Intro to Computers Internal Computer Functions Programming Logic COBOL COBOL, CICS Assembly Language Programming COBOL,CICS, SQL Systems Analysis & Design Intro to Internet Microcomputer Operating Systems Spreadsheet Use & Design Visual Basic Programming Database Use & Design Systems Analysis & Design Network Fundamentals	Business Technologies	AAB
Hiram College	Computer Science	Intro to Computer Science, Intro to Programming, Algorithm Design, Computer Organization, Data Base Design, Programming Languages, Systems Analysis & Design	Computer Science	BA
John Carroll University	Computer Science	Computer Analysis of Statistics Data Structures & Algorithms Cobol Programming Java Programming PC Applications Computer Graphics Programming Languages Artificial Intelligence Software Engineering Operating Systems	Mathematics & Computer Science	B A

Institution Name	Program Name	Core Course	Department/Division	Award Level
Kent State University	Computer Information Systems	Computer Applications Systems Analysis Principles of Systems Development Computer Programming for Business Systems Simulation Data & File Technology Data Integration Communications & Networks Information Systems management Software Integration	Management & Information Systems	B S Ph D
Kent State University	Systems Engineer			Certificate
Kent State University	Solutions Developer			Certificate
Kent State University	Computer Science	Computer Programming (high-level language, structured programming, program design, expressions, data control, arrays, records, strings & functions) Data Structures Computer Org. & Assembly Language Symbolic Programming Languages Speed programming Numerical Computing Database system design Structured Programming languages Operating Systems Systems Administration Systems Programming Artificial Intelligence Design & Analysis-Algorithms Computer Graphics Software Engineering Communication Networks	Mathematics & Computer Science	Ph D MA B A
Malone College	Computer Science	Fundamental Computer Applications Principles of computer science Data Structures Computer Architecture Analysis & Design of Algorithms Software Engineering Assembler Visual Programming Networking Internet/Web programming COBOL Programming Languages Principles of Operating Systems Database Design & Implementation	Department of Math & Computer Science	B.A
Notre Dame College	Information Systems	Business Programming Languages (C++) Intro to Java Programming Design & Implementation with Programming Languages (C++) Advanced Visual Basic Graphic Design Multimedia Development Web Site Design & Development Network Essentials Database Management Systems Operating Systems Info Systems Theory & Practice Systems Analysis Information Tech. Hardware & Software	Business	BA

Institution Name	Program Name	Core Course	Department/Division	Award Level
Oberlin College	Computer Science	Principles of Comp Scie Algorithms, Structures & Abstractions Programming Languages Database Systems Operating Systems Advanced Software Development	Natural Sciences/Computer Science	BA
The University of Akron	Computer Information Systems- Programming Specialist	Introduction to Logic/Programming Internet Tools Operating Systems Visual BASIC Database Concepts Java Programming Systems Analysis & Design C++ Programming Client Server Programming	C&T/Business Technology	AAS Certificate
The University of Akron	Computer Science	Intro to Visual Basic programming Intro to Programming Languages Intro to FORTRAN Programming Intro to Programming COBOL Programming C++ Programming Data Structures & Algorithms Programming Application with COBOL Assembly Language Programming Survey of Programming Languages JAVA Fundamentals of Data Structures Intro to C & UNIX	AATS & Sciences/Math & Computer Science	MA BA Certificate
Walsh University	Computer Science	Computers – Trends & Social Issues Web Publishing- Intro to the Internet Programming Visual Basic Fortran COBOL Database Techniques Management Info Systems Object-Oriented Programming in C++ Principles of Computer Languages Operating Systems Computer Science		BS
Youngstown State University	Computer Information Systems	Survey of Comp Scie & Info Systems, Programming & Problems Solving, Data Structures & Objects, Development of Data Bases, Networking Concepts & Administration	Computer Science & Information Systems	BS AAS
Youngstown State University	Computer Science	Computer Literacy, Global Electronic Info Resources, Survey of Modern Operating Systems, Survey of Language Topics, Programming in C, Data Structures, Programming & Problem solving.	Computer Science & Information Systems	BS

## DATABASE ADMINISTRATION

- While coursework in Database Administration is often integrated into other IT programs of specialty, there are currently no programs which focus exclusively on the production of these specialized IT workers in NE Ohio.
- There were no Database Administration programs offered in 2000/01 and no degreed workers produced in NE Ohio.
- While no degree programs exist, Kent State University offers a certificate of proficiency in Database Administration.

Database Development/Administration		
	2000 Enrollment	2000 Graduates
Non Credit	0	0
Certificate	0	0
Associate Degree	0	0
Bachelor Degree	0	0
Master Degree	0	0
Ph D	0	0
Total	0	0

*These programs prepare IT workers in conceptual logical data modeling and physical design, database implementation, maintenance, and support. Instruction is provided on the design of storage and retrieval systems for raw data in accordance with business use and applications. In addition to database creation, individuals learn how to modify databases, update databases, and extract data for reporting/presentation purposes. Back-up/recovery strategies, troubleshooting, and security maintenance are also common applications for this line of education/training and work. Program offerings are limited across NE Ohio. More often database administration course work is integrated into other IT education/training programs, but on a limited nature.*

Institution Name	Program Name	Core Courses	Department /Division	Award Level
Kent State University	Database Administrator			Certificate

**SOFTWARE DEVELOPMENT & ENGINEERING**

<b>Software Development</b>		
	<b>2000 Enrollment</b>	<b>2000 Graduates</b>
Non Credit		
Certificate		
Associate Degree	188	5
Bachelor Degree		
Master Degree		
Ph D		
<b>Total</b>	<b>188</b>	<b>5</b>

- Interestingly, Software Development programs are offered at the associate degree level only.
- Following production patterns at the two-year level, only 5 degreed workers with IT specialty in Software Development were produced in 2000/01.
- With enrollment somewhat strong, future production might become greater within this IT cluster.

*These programs prepare individuals to apply general engineering principles and methodologies to software development*

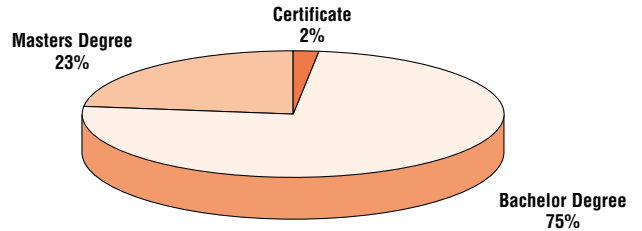
<b>Institution Name</b>	<b>Program Name</b>	<b>Core Courses</b>	<b>Department /Division</b>	<b>Award Level</b>
Lorain County Community College	Computer Information Systems – Software Development	Microcomputer Applications Operating System Interfaces Local Area Networks Database Design & Implementation Program Development Using Visual Basic Programming on the AS/400 Systems Development Advanced RPG COBOL Fundamentals	Division of Business	AAB
Stark State College of Technology	Computer Science & Engineering Technology	Engineering Computer Applications Internet/Intranet Software Design Software Engineering Principles Intro to Computer Networking Optics Introduction to C++ Programming Java Programming in Computer Science Inter-group Communications Operating Systems for Software Developers Data Acquisition/Analysis Database Design/Interface for Software Developers Software Engineering Design & Development with COM Distributed Applications with Visual Basic Advanced Java Programming Analyzing Software Requirements & Developing Solutions	Engineering	AAS

## INFORMATION SYSTEMS MANAGEMENT

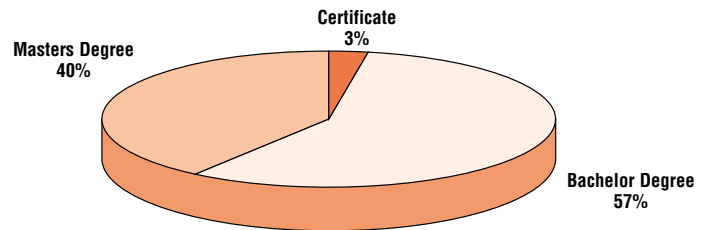
- Similar to Programming & Systems Analysis, enrollment of IT specialists in Information Systems Management is greatest at the advanced degree level.
- However, production of specialists in the Information Systems Management cluster was weak with only 65 degreed graduates in 2000/01

Information Systems Management		
	2000 Enrollment	2000 Graduates
Non Credit		
Certificate	8	2
Associate Degree		
Bachelor Degree	273	38
Master Degree	86	27
Ph D		
Total	367	67

**Information Systems Management:  
Enrollment by Level Award (2000)**



**Information Systems Management:  
Graduates by Level of Award (2000)**



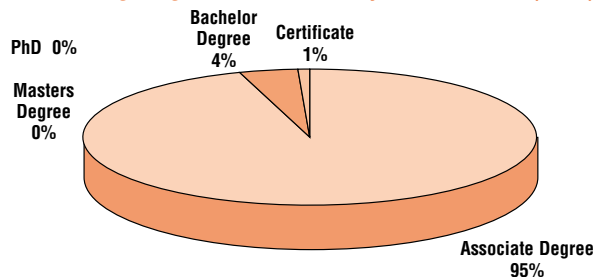
*These education and training programs prepare IT workers across a spectrum of IT applications. Generally individuals are trained to provide operational support for a wide variety of information systems, to identify and solve systems problems, and to monitor and analyze system performances. These individuals also must learn how to plan and prioritize work flow. They are programs that were difficult to classify under microcomputing technology, networking technology, digital media technology, database management/warehousing, or programming and systems analysis because they incorporate course work in all of these areas. This cluster focuses more heavily on management of resources, personnel, & information.*

Institution Name	Program Name	Core Courses	Department /Division	Award Level
David N Myers University	Information Management	Intro to Microcomputers Info Systems & Technology Operating Systems Management Computer Applications in Business Systems Analysis Systems Design E-Business Network Administration System Evaluation & Forensics	Business Division	BS Certificate
Hiram College	Computer Systems Management	Program combines computer science and management courses Intro to Comp Science Intro to Programming Interface Design Internet Administration Software Evaluation Computer Ethics Project Management	Computer Science	BA
The University of Akron	Management Info Systems	Data management for Information Systems Analysis and Design of Information Systems Telecommunications for Business Decision support and Expert Systems E-Business Technologies & Infrastructures Business Information Systems Business	Administration/Management	MA BA Certificate

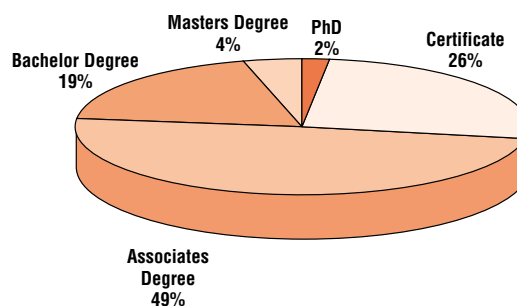
## CROSS-CUTTING IT PROGRAMS

- The region's second largest enrollment of IT specialists was in Cross-Cutting programs (programs that prepare individuals in a variety of IT specialty areas) with nearly 8,000 students.
- This may be significant given low enrollment and production in areas like Networking, Database Administration, and Software Engineering.
- Similar to Computer Systems Support, Maintenance, Repair, Networking Technology, and Digital Media Technology, nearly half Cross-Cutting programs are offered at the associate degree level.
- Production of Cross-Cutting specialists, which is strongest at the associate degree level, is moderate and comparable to Digital Media Technology.

**Cross Cutting Programs: Enrollment by Level of Level (2000)**



**Cross-Cutting Programs: Graduates by Level of Award (2000)**



Cross-Cutting Programs		
	2000 Enrollment	2000 Graduates
Non Credit		
Certificate	58	55
Associate Degree	7,179	106
Bachelor Degree	282	41
Master Degree	7	8
Ph D	11	5
Total	7,534	215

*These programs prepare individuals in a variety of areas including Systems Support, Maintenance/Repair, Networking, Digital Media, Database Administration, Systems Development & Integration, Software Development, and Information Systems Development.*

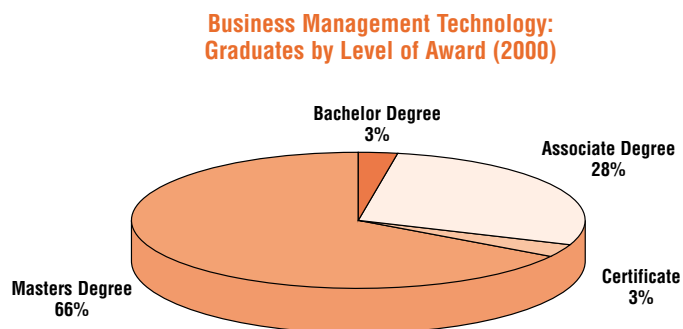
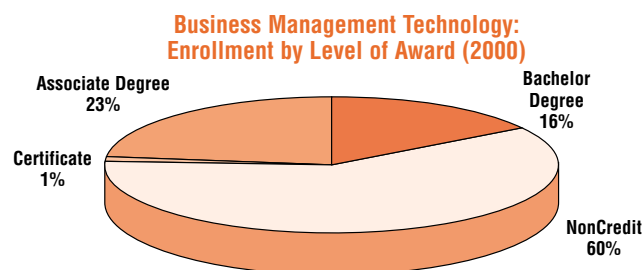
Institution Name	Program Name	Program Name	Department /Division	Award Level
Baldwin Wallace	Computer Science	Intro to Computer Info Systems Computer Application Software Fundamentals of Comp Scie Programs & Applications Digital Topics Information Systems Telecommunications (LAN,WAN,VANS, OSI) Intro to Data Base Systems Building Local Area Networks Assembly Language Comp Architecture & Hardware Operating Systems Systems Analysis & Design	Computer Science	BS
Case Western Reserve University	Computer Engineering	Intro to Data Structures Logic Design & Computer Organization Digital Logic Laboratory Systems Programming Semiconductor Electronic Devices Computer Architecture Intro to Operating Systems or VLSI/CAD	Electrical Engineering & Computer Science	Ph D MS BS
David N Myers University	Information Technology	Electronic Commerce Systems Maintenance & Planning Database Management Info & Decision Support Systems Operating Systems Internet & Web Technology Network Administration (WAN, LAN) Intro to Programming Using Basic Systems Development Life Cycle	Business Division	BS

Institution Name	Program Name	Program Name	Department /Division	Award Level
Kent State University	Computer Technology	C/C++ Programming Visual Database Development Operating Systems Networking Workgroup Productivity Software Assembly Language Programming Digital Systems Computer-Aided Drafting Computer Animation	Technology	AAB
Lakeland Community College	Information Systems	Information Systems3 Programming Logic Computer & Information Processing Intro to Microsoft Windows Using an HTML Editor Intro to Web Design Microsoft Networking Essentials Networking Technologies Netware Administration Intro to Oracle SQL Develop Oracle PL/SQL Program Units Using Windows Applications: Presentation Graphics	Business Technologies	AAB/Cert
Stark State College of Technology	Computer Technology	Operating System Mainframe Operating Systems/JCL COBOL Programming Java Programming	Business	AAB
		(Tracks in : Application Developer, AS/400 Specialist Database Administrator Database Developer Microcomputer Integration) Introduction to Computer Programming Microcomputer Applications System Design & Development Data Processing Field Project		

## BUSINESS MANAGEMENT TECHNOLOGY

- Degree programs in Business Management Technology are offered at both associate and bachelor degree levels.
- However, enrollment is lowest in this cluster with only 68 students in degreed programs.
- Interestingly, although there were no students enrolled at the master degree level, one-half of all Business Management Technology graduates were at this level.
- The production of Business Management Technology specialists is somewhat weak, if considered an area of priority from a demand perspective.

Business Management Technology		
	2000 Enrollment	2000 Graduates
Non Credit	105	0
Certificate	2	1
Associate Degree	40	8
Bachelor Degree	28	1
Master Degree		19
Ph D		
Total	175	29



*These programs are similar to Office & Micro-computer Technology training in that individuals are trained as IT-enabled workers or end-users of technological applications. Individuals with some workplace experience and desire to move into managerial/supervisory positions, or those in management positions seeking to upgrade their computer skills are the primary target for these programs. The curriculum places strong emphasis on work processing, spreadsheets, database development, Internet/Web page design, and other software applications. These programs also emphasize instruction in accounting, finance, marketing, economics, business statistics, business law, and technical writing which are key distinguishing features from the Office and Microcomputing Career Track. Some programs introduce programming concepts and AS/400 applications as well.*

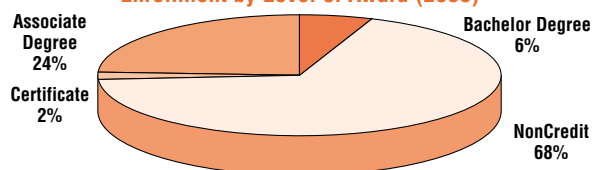
Institution Name	Program Name	Core Courses	Department/ Division	
Cleveland State University	Accounting & Financial Info Systems	Systems Analysis Methods Modern Database Design & Implementation Object-Oriented Programming for Information Systems Electronic Commerce	College of Business	MA
Kent State University	Advanced Internet Certificate			Certificate
Lakeland Community College	Using the Internet for E-commerce			Non Credit
Lorain County Community College	Business Administration –Management Major	Microcomputer Applications Exploring the Internet	Division of Business	AAB
Lorain County Community College	E-Business Technology Major	Operating System Interfaces Microcomputer Applications Introduction to E-Commerce Program Development Using Visual Basic Database Design & Implementation Web Development Web Database Integration Scripting in the Client Server Environ. Local Area Networks Systems Development	Division of Business	AAB
The University of Akron	Business Management Tech: Data Management Option	Fundamental Computer Concepts Intro to Windows Keyboarding Software Fundamentals	C&T/Business Technology	AAS Certificate
Ursuline College	Business Info Technology	Intro to the Internet Systems Analysis & Design Business courses	Professional Studies	BA

## OFFICE & MICROCOMPUTER TECHNOLOGY

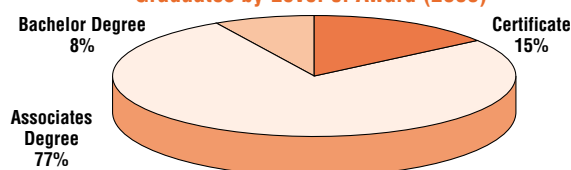
- Similar to Business Management Technology, Office and Microcomputer programs are offered at both associate and bachelor degree levels.
- Enrollment is stronger for Office & Microcomputer Technology than it is for Business Management Technology, particularly at the non credit and associate degree levels. Because these programs emphasize personal computer applications, they are important to the regions production of IT-enabled workers across industries and occupations. These programs help to produce competent end-users of technology.
- Production of Office & Microcomputer Technology specialists appears to follow enrollment patterns and is stronger than it is in Computer Support, Networking, Software Engineering, and Business Management Technology.

Office & Microcomputer Technology		
	2000 Enrollment	2000 Graduates
Non Credit	813	0
Certificate	18	12
Associate Degree	280	86
Bachelor Degree	75	11
Master Degree		
Ph D		
Total	1,186	109

**Office & Microcomputer Technology:  
Enrollment by Level of Award (2000)**



**Office & Microcomputer Technology:  
Graduates by Level of Award (2000)**



*These education/training programs help prepare IT-enabled workers, primarily for front office work. Many of the “microcomputing” degree and certificate programs are also applicable to any individual interested in learning how to use a personal computer for a variety of applications. Training usually focuses on general keyboarding skills, use of PC operating systems (DOS and Windows), and word processing, spreadsheet, database development, desktop publishing, and multi-media presentation applications. Heavy emphasis is placed on Microsoft Office applications (Word, Excel, Access, Power Point, Project Management, Desktop Publishing). Some programs incorporate fundamentals of exploring and finding information on the Internet. They may also include introductory course work on PC design, installation, maintenance, and repair but this does not comprise the primary emphasis of these programs. They are generally offered by the Business Divisions/Academic units.*

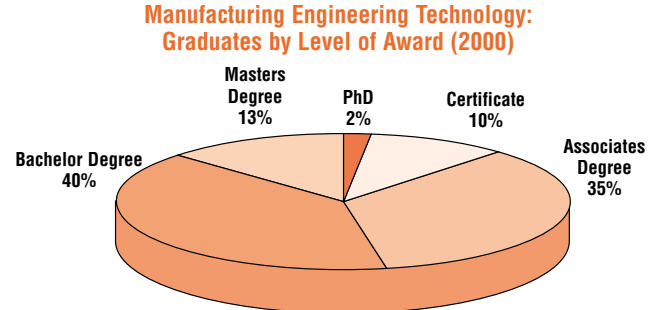
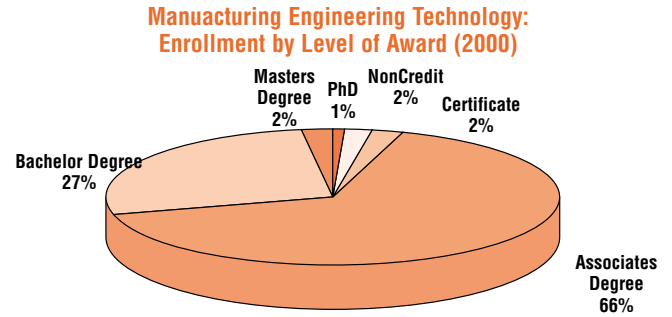
Institution Name	Program Name	Core Courses	Department /Division	Award Level
Baldwin Wallace	Information Technology	Intro to Computer Info Systems HTML/WWW Excel, Access, PowerPoint	Business Communication Computer Science	Certificate
David N Myers University	Information Processing Administration	Intro to Keyboarding Ten-Key Basics Basic Word Processing Applications: Microsoft Word Spread Sheet Basic: Excel Presentation Basics: PowerPoint Data Base Basics: Access	Business Division	BS Certificate
Kent State University	Microcomputer Application			Certificate
Kent State University	Internet			Certificate
Kent State University	Entrepren/Microcomputer			Certificate
Lakeland Community College	Excel Spreadsheets			Non Credit
Lakeland Community College	Introduction to PCs			Non Credit
Lakeland Community College	Managing Data Fast & Easy			Non Credit
Lakeland Community College	Introduction to the Internet			Non Credit

Institution Name	Program Name	Core Courses	Department /Division	Award Level
Lakeland Community College	Word Processing			Non Credit
Lakeland Community College	Introduction to Microsoft			Non Credit
Lakeland Community College	Create Powerful Presentations			Non Credit
Lorain County Community College	Administrative Office Information Systems	Intro to Windows Keyboarding skills Development Admin Office Technology Principals of Layout & Design Excel Spreadsheets	Division of Business	AAB
Stark State College of Technology	Microcomputer Applications Technology	Microcomputer Applications Visual Basic Programming Microsoft Access Programming Introduction to Database management Systems AS/400 Concepts and Facilities Web Tools, Design & Development Networking Technologies Netware Administration Data Modeling & Design Linux Operating System PC Upgrading & Maintenance Microcomputer Applications for Application Developers	Business	AAB
Stark State College of Technology	Administrative Information Technology	Keyboarding/Formatting Computer Systems and Microsoft Windows Computer Design Concepts Desktop Publishing –Microsoft Publisher Database Applications-Access PowerPoint Presentations Microsoft Word Adobe Pagemaker	Business	AAB/Cert
Ursuline College	Microcomputers applications	Intro Comp Program in Basic Word Processing Spreadsheets Database Management Presentation graphics Desktop Publishing	Professional Studies	Certificate
Youngstown State University	Office Information System	Survey of Computer Science & Information Systems, Programming & Problem solving, Basic Programming, System Configuration & Maintenance, Development of Data Bases, Networking Concepts & Administration	Computer Science & Information Systems	BS AAS

## MANUFACTURING ENGINEERING TECHNOLOGY

- Manufacturing Engineering Technology Programs are offered at all levels of award.
- Similar to the majority of IT clusters, enrollment in Manufacturing Engineering Technology programs is strongest at the associate degree level.
- Yet, production of IT specialists was highest at advanced degrees (4 year and beyond).
- Overall, production of IT specialists in Manufacturing Engineering Technology cluster was strong with 372 degreed workers produced in 2000/01 alone. However, overall production may be considered low when the sheer number of educational programs in existence is considered (n=27).

Manufacturing Engineering Technology		
	2000 Enrollment	2000 Graduates
Non Credit	56	
Certificate	69	36
Associate Degree	1,866	131
Bachelor Degree	756	150
Master Degree	70	47
Ph D	34	8
Total	2,851	372



*These program include CAD, CAM, and Electronic/Electrical Engineering. They are more traditional in nature but very related to technological applications in manufacturing.*

Institution Name	Program Name	Core Courses	Department/ Division	Award Level
Case Western Reserve University	Electrical Engineering	Logic Design & Computer Org Intro to Data Structures (programming language C++) Digital Systems Design Systems Programming Intro to Operating Systems Programming Language Concepts Computer Communications Network Analysis of Algorithms Electronic Circuits Data Acquisition & Control Elementary Computer Programming	Electrical Engineering & Computer Science	Ph D MS BS
Cleveland State University	Electronic Technology	Microprocessor & Digital System Design Embedded Microprocessor Systems Digital Signal Processing	College of Engineering	BS
Cleveland State University	Industrial Engineering	Operations analysis I & II (Formulation, analysis, interpretation & computer implementation of deterministic optimization model in engineering ) Applications of Programmable Logic Controllers Industrial Automation Systems Simulation Engineering Design	College of Engineering	MS BS

Institution Name	Program Name	Core Courses	Department/ Division	Award Level
Cleveland State University	Electrical Engineering	Intelligent Control Systems Antenna Design Modern Digital Design Computer Architecture Digital Communications Mobile Communications Satellite Communications High Performance Computer Architecture Distributed Computing Systems Computer Networks Advance Digital Design Engineering Applications of Programmable Logic Controllers Microprocessors	College of Engineering	Ph D MS BS
Cuyahoga Community College	Manufacturing Technology	Intro to CAD Manufacturing Technology Skills CNC Programming/Operations CAM Principles	Engineering Technologies	AAS, Cert in CAM
Cuyahoga Community College	Electrical/Electronic Engineering-Basic	Computer Applications & Programming Introduction to AutoCAD Digital Circuits/Microprocessors I & II Electrical Design Project		AAS
Cuyahoga Community College	Electrical/Electronic Eng-Biomedical	Computer Applications & Programming Digital Circuits/Microprocessors I & II Biomedical Design Project	Engineering Technologies	AAS
John Carroll University	Engineering Physics Major: Computer Engineering Specialization	Basic Electronics Computer Logic Design & Microcomputers Computer Logic Design & Microcomputers Laboratory Applied Digital Electronics	Physics	BS
Kent State University	Computer-Aided Drafting/Design Technician			Certificate
Kent State University	Robotics Systems			Certificate
Lakeland Community College	Computer Integrated Manufacturing	Intro to Machine-Tool Technology Introduction to Machine-Tool Set-Up & CAM Introduction to Electrical Devices & Controls Introduction to Computers for Manufacturing Applications Instrumentation & Process Control Computer Numerical Control Part Programming (CNC) Computer Assisted Part Programming Programming CNC Machining Centers Networking CAD/CAM System CAD/CAM Software	Engineering Technologies	AAS/Cert
Lakeland Community College	Mechanical Engineering Technology	Computer Based Descriptive Geometry Introduction to Technology Intro to Engineering Drawing & AutoCAD Technical Communications Computer Based Electronic Drafting Computerized Instrumentation Advanced AutoCAD Jig & Fixture Design	Engineering Technologies	AAS/Cert

Institution Name	Program Name	Core Courses	Department/ Division	Award Level
Lakeland Community College	AutoCAD		Engineering Technology	Non Credit
Lorain County Community College	Manufacturing Engineering Technologies – Computer Aided Design Operator	Technical Problem Solving Manufacturing Processes Detailing & Dimensioning Introduction to Computer Numerical Control	Engineering Technology	AAS Certificate
Lorain County Community College	Manufacturing Engineering Technologies- Computer Aided Machining Operator	Technical Problem Solving Introduction to Computer Numerical Control Manufacturing Processes Geometric Dimensioning & Tolerancing	Engineering Technology	AAS
Lorain County Community College	Manufacturing Engineering Technologies – Mechanical Design Major	Detailing & Dimensioning Introduction to Computer Numerical Control Manufacturing Processes Machine Design	Engineering Technology	AAS
Lorain County Community College	Automation Engineering Technologies – Systems Specialist Major	Robotics & Automated Manufacturing Electrical Circuits Technical Problem Solving Programmable Logic Controllers Computer Integrated Manuf Workcell Interfacing Manufacturing processes Instrumentation & control	Engineering Technology	AAS
Lorain County Community College	Electronic Engineering Technology – Applied Electronics	Fabrication Processes for Electronics Programmable Logic Controllers Network Installation & Diagnostics Digital Electronics Electronic Devices Introduction to Computer Aided Drafting Analog & Digital Data Communications	Engineering  Engineering	AAS
Stark State College of Technology	Design Engineering Technology	Intro to Design & Mechanical Engineering Technologies Basic, Intermediate, & Advanced AutoCAD Die Design		AAS
Stark State College of Technology	Electrical and Electronic Engineering Technologies	Electronic Devices & Circuits PC Upgrading & Maintenance Digital Integrated Circuits Microprogramming Microprocessors Digital Communication & System Analysis Biomedical: Instrumentation; Standards & Safety; Operating Room Equipment; Therapeutic Equipment Microsoft SQL Server Electronic Telecommunications Computer Networking Personal Computer Operating Systems Workstation Interfacing UNIX System Administration MS Windows 200 Professional, Server & Network Infrastructure Implementing & Administrating MS Windows 2000 Designing A MS WIN2000 Network Service Infrastructure UNIX Operating Environment		AAS

Institution Name	Program Name	Core Courses	Department/ Division	Award Level
The University of Akron	Manufacturing Engineering Technology	Manufacturing Processes Technical Report Writing Computerized Manufacturing Control CNC Programming Robotics & Automated Manufacturing	C&T/Engineering & Science Technology	AAS
The University of Akron	Drafting & Computer Drafting Technology	Manufacturing Processes Technical Drawing Computer Aided Drawing Software Applications for Tech Drafting Design Problems Electrical & Electronic Drafting	C&T/Engineering & Science Technology	AAS Certificate
The University of Akron	Electronic Engineering Technology	Software Applications for Technology DC Circuits AC Circuits Electronic Devices Intro to Digital Fundamentals Digital Circuits Microprocessor Applications Computer Control of Automated Systems	C&T/Engineering & Science Technology	BS AAS Certificate
The University of Akron	Automated Manufacturing & Manufacturing Engineering Technology		C&T/Engineering Technology	BS
The University of Akron	Computer Engineering	Computer Systems VLSI Design Introduction to computer Science Data Structures & Algorithms Computer Organization	Engineering/Electrical Engineering	BS
The University of Akron	Electrical Engineering	Programming for Engineers Circuits Switching and Logic Communication & Signal Processing Electromagnet Electronic Design Operating Systems Concepts Programmable Logic	Engineering/Electrical Engineering	MS
Youngstown State University	Electrical Engineering Technology	Control Systems, digital systems, computer engineering, microprocessor, appliances, communications, computer-aided design, power systems, power electronics, & sensors	School of Technology	BS AAS

## E. ENROLLMENT & GRADUATE SUMMARY BY IT CLUSTER

### ENROLLMENT

Cluster	Certificate	Associate	Bachelor	Master	Ph D	Advanced Degrees combined*	Row Total
Computer Systems Support, Maintenance, Repair	43	631					674
Networking Technology	8	307					315
Digital Media Technology	162	814	341				1,317
Programming & Systems Analysis	18	1,450	2,419	145	39	6,862	10,933
Software Development		188					188
Information Systems Management	8		273	86			367
Cross-Cutting Programs	58	7,179	282	7	11		7,537
Office & Microcomputer Technology	18	280	75				373
Business Management Technology	2	40	28				70
Manufacturing Engineering Technology	69	1,866	756	70	34		2,795
<b>Column total</b>	<b>386</b>	<b>12,755</b>	<b>4,174</b>	<b>308</b>	<b>84</b>	<b>6,862</b>	<b>24,569**</b>

\* This figure represents a combined total of bachelor, master & Ph.D degrees from Kent State University  
 \*\* Total does not include noncredit enrollment

### GRADUATES

Cluster	Certificate	Associate	Bachelor	Master	Ph D	Row Total
Computer Systems Support, Maintenance, Repair	22	24				46
Networking Technology		34				34
Digital Media Technology	6	32	184			222
Programming & Systems Analysis	10	107	408	112	14	651
Software Development		5				5
Information Systems Management	2		38	27		67
Cross-Cutting Programs	55	106	41	8	5	215
Office & Microcomputer Technology	12	86	11			109
Business Management Technology	1	8	1	19		29
Manufacturing Engineering Technology	36	131	150	47	8	372
<b>Column total</b>	<b>144</b>	<b>533</b>	<b>833</b>	<b>213</b>	<b>27</b>	<b>1,750</b>

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## F. ANALYSIS OF IT SUPPLY IN RELATION TO REGIONAL DEMAND

Two primary sources of data have been used to compare NE Ohio demand to the supply data produced by this study. The first source is a study that was conducted for the *Ohio Board of Regents* and looked at demand both at national and state levels. This study reviewed statistical data at the national level and offered qualitative evidence as to the demand among Ohio employers. The second, and more important source, is a study conducted by the *Greater Cleveland Growth Association* to assess IT staffing needs within Northeast Ohio. Matching demand data with production of IT workers in the region will help to inform the regions system of higher education of new service needs and opportunities.

Based on evidence from the OBOR study, demand for IT workers must be considered in the context of the IT industry (and large non-IT employers) versus all other employers of various types and sizes. For example, the greatest demand for IT workers among IT firms and large non-IT employers tend to be in the cluster of Programming and Systems Analysis. As might be expected, these employers tend to provide more jobs for programmers, system analysts, and software developers than do other companies. When small and medium sized firms from all non-IT industry sectors are considered, Computer Support/Repair, Networking, and Digital Media technology positions tend to be in greatest demand. In fact, the *Information Technology Association of America* reported in 2000, that 70% of all new IT specialty jobs will come from industries with 50-99 employees.

With respect to production of IT workers in our region, it would appear that the appropriate education/ training programs are offered (i.e in an area for which there is great demand). The question is not whether the training is misdirected, but rather whether enough IT workers are being produced to satisfy regional demand. In comparing demand to supply of IT workers, the need for IT specialists far outstrips supply. As indicated in the *Ohio Board of Regents* study, sources have identified widespread demand for Computer Support personnel, Networking specialists, and Digital Media specialists among non-IT establishments of all types and sizes. However, this survey reveals that Computer Support and Networking are two areas we currently produce the fewest workers in Northeast Ohio.

In addition, the *Greater Cleveland Association* study found that while our region's production of degreed workers is highest in the area of Programming & Systems Analysis, it is still far smaller than actual demand (as of October, 2000). For example:

- Although vacancies for Programmers (1,997) and Systems Engineers (651) totaled 2,452 in October, 2000, only 651 individuals had graduated from related programs during 2000/01.

Similar discrepancies were apparent for other IT clusters:

- There were 744 vacancies for Network Specialist in October, 2001, compared to only 34 graduates.
- There were 1,801 openings for Technical Support positions compared to only 46 graduates.
- Software Engineering vacancies totaled 435 but only 5 graduates were produced in 2000/01.
- The gap between Information System Personnel demand (584) and production of workers (67) was also large.
- There were no corresponding 2000/01 graduates for the 720 vacancies in Database Administration reported for October, 2000.

The supply of 2000/01 graduates exceeded demand in two areas:

- The 222 Digital Media Technology graduates exceeded the 148 vacancies reported for October, 2001.
- Although there were 372 Manufacturing Engineering Technology graduates in 2000/01, the number of vacancies in October, 2000 was near zero.
- Although the Growth Association reported demand in the area of Technical Sales, we found no evidence that programs exist in this area or that technical sales is integrated into any of the existing Business programs.

IT Professionals according to Greater Cleveland Growth Association	Equivalent IT Cluster	Total Number of August, 2000 FT Openings in 8-County Region of NE Ohio (Estimate)	2000/01 Graduates by IT Cluster
Programmers Application Systems Analysts Systems Engineers	Systems Development & Integration Systems Development & Integration Systems Development & Integration	1,997 Approaching zero 455	651
Network Specialists	Networking Technology	744	34
Technical Sales	Other	148	0
Info Systems Operators/Analysts	Information Systems Management	584	67
Technical Support Reps.	Computer Systems, Support, Maintenance, Repair	1,801	46
Software Engineers-Architects	Software Engineering	435	5
Database Administrators	Database Administration	720	0
Technical Program Managers	Other	732	0
Digital Media Specialists	Digital Media Technology	148	222
Other	Other		
Quality Assurance & Testing	Manufacturing Engineering Technology	Approaching zero	372
Technical Writers	Other	Approaching zero	0
Product Managers	Other	436	0

The study by the *Greater Cleveland Growth Association* also categorized job vacancies based on educational requirements. The greatest demand was for IT workers with a minimum of a bachelor degree. Over two thirds (67%) of IT firms indicated a bachelor degree as a minimum educational requirement. Although demand for IT workers with a minimum of a bachelor education was not as great among non-IT organizations, it was significant at 46 percent. Given this information, it is important that the regions institutions of higher education place a high premium on producing IT professionals at the bachelor level or higher. As indicated earlier, results of this study indicate that enrollment is highest at associate level (50%), yet when advanced degrees are combined, the region is producing more IT specialists (graduates) at four year levels and beyond than it is at the associate degree level. Greater production of four year IT graduates may be critical to our regions ability to attract and retain IT establishments and other large IT dependent employers.

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### III. DETAILED FINDINGS PART II: PRODUCTION OF IT-ENABLED WORKERS

As alluded to in the introduction, not only does our region need an adequate supply of IT specialists for economic development, but also a workforce that is technologically competent across all industry sectors and occupations. IT-enabled workers are necessary for overall productivity and competitiveness of this region.

To determine the extent to which colleges/universities are producing IT-enabled workers, an assessment was made of all course work offered by institutions of higher education. Course catalogs from each of the participating institutions were reviewed to identify individual IT-related courses embedded within non-IT academic disciplines.

As might be expected, results indicate that the greatest integration of IT learning and instruction is occurring in the field of education. Many educational programs across the region are offering IT-related course work within their curricula. Courses most frequently offered by educational disciplines include: Instructional Technology, Instructional Design & Delivery, Technology in the Classroom, Telecommunications in Education, Design & Production of Educational Media, and Education Technology. Although somewhat lower than education, accounting and art programs also incorporated IT-related courses into instruction. Other disciplines integrating IT-related courses were English, Health Care, Music, Public Administration & Urban Studies, Psychology/Sociology, and Tourism.