Texas State
Technical College
System

2001-2002 Mid-Year
Carl D. Perkins Grant Report

Forecasting Technical Program Needs

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Programs for Emerging Technologies

Introduction

In the 76th Regular Session, the Texas State Legislature charged Texas State Technical College System (TSTC) with "developing and administering a program to forecast the types of technical education programs that are needed to maintain and improve the state's economic and technological competitiveness" (SB 1819) (see Appendix A). TSTC received funding for this purpose from the Texas Higher Education Coordinating Board (THECB) under a 2001-2002 Carl D. Perkins planning grant.

The objective of this planning grant was to develop a process for identifying and evaluating potential emerging-technology programs that would have a positive impact on the State's economy and enable responsible decision makers to select relevant curricula choices to help ensure a skilled workforce for future Texas employers. Assuming that this process proves successful and provides for more informed decision making, it is envisioned that the process will be institutionalized and direct funding obtained to assure its sustainability.

To assist in the conduct of this project, TSTC has contracted with Technology Futures, Inc. (TFI), an Austin, Texas-based research and consulting firm with more than 24 years experience in technology forecasting. Since contract award, representatives of TSTC and TFI have worked in close partnership to achieve the objectives of this project in coordination with the Texas State Leadership Consortium for Curriculum Development (CCD), the THECB, and numerous other key stakeholders.

This report presents the following resulting from the discovery and planning phase of the mid-year 2001-2002 project:

- General observations and conclusions.
- Review and analysis of survey results from the statewide Texas Community and Technical College Curriculum Development Survey.
- Methodology for identifying Programs for Emerging Technologies (PET).
- Technology forecast methodologies and desired outcomes.

- Practical application of the PET Process (next steps).

One of the major activities of this project was a survey of the State's community and technical colleges to better understand the current methods of identifying new programs and the specific criteria used when considering program development opportunities. This survey, coordinated with the CCD and supported by the THECB, was submitted to all of the 69 community and technical colleges in Texas. An impressive 88.4% of colleges responded to the survey, and the results provided insight into these development efforts. This survey and an analysis of results are included in this report and will provide the reader with significant insight into curriculum development processes. This analysis is also being distributed to all Community and Technical College Instructional Officers and Technical Deans of the 69 colleges.

A process for identifying and analyzing emerging-technology program opportunities has been developed based largely on the needs and desires expressed by college deans throughout the state plus direct input from a smaller representative group of community and technical college deans through coordination with the CCD and the formation of a CCD Forecasting Subcommittee. This process, entitled *Programs for Emerging Technologies (PET)*, is comprised of three essential components:

1) Identifying promising emerging-technology program areas.

2) Conducting meaningful technology forecasts for the identified technologies.

3) Disseminating resulting findings and technology forecasts to the State's community and technical colleges and other curriculum development stakeholders to promote informed and proactive decision-making.

Each of these components is described in greater detail later in this report. This report represents four months of intensive research and development around this process, and the reader should be aware that additional development and further refinement will continue into Fiscal Year 2003. These additional efforts will be made possible by a Carl D. Perkins continuation grant from the THECB. These future development plans are detailed in this report, as are suggestions for future research initiatives.

Observations and Conclusions

- Currently, there is no process in place to initiate and research promising emerging-technology programs[1] for Texas community and technical colleges.
- Formal technology forecasting techniques are not typically employed by Texas community and technical colleges to determine future demands, although many key stakeholders express the need for a more reliable methodology for identifying promising emerging-technology programs.
- A major factor in program selection is meeting existing local industry workforce requirements. Therefore, curriculum development efforts and data focus on meeting present-day local needs, rather than anticipating future statewide needs or developing emerging-technology programs to attract new industries to a region.
- Texas's community and technical colleges tend to cooperate in developing and conducting programs. As advanced technologies become increasingly important to the State's industries, such cooperation will be essential to the colleges' ability to provide programs requiring special faculty, extensive laboratory facilities, and expensive equipment.
- Advanced Technology Certificates, Certificates, Local Needs, and Special Topics are more dynamic than Associates of Applied Science (AAS) programs. The majority of "new" associate degree programs already exists in some capacity at other colleges, while truly emerging-technology AAS programs average less than two per year.
- Responsive curriculum development and community and technical college program offerings are an important component of the state's economic competitiveness. Therefore, a process that identifies potential emerging-technology programs and leads to the development of additional new technology programs to meet projected future needs should be created.

[1] Career Development Resources currently publishes emerging/evolving occupational research.

Community and Technical College Curriculm Development Survey

To assist in meeting the objectives of this project, a survey of the Texas public two-year colleges was conducted by the TSTC/TFI team. This survey was coordinated with the CCD and supported by the THECB (see Appendix B).

Survey Purposes

The survey had two basic purposes:

1) To gain an understanding of how the colleges have identified and implemented technology-based curricula in the past. It was apparent that this understanding would assist in developing a process that builds on past experience and that takes fullest advantage of the lessons that had been learned.

2) To determine the criteria that colleges currently use in selecting emerging-technology programs for development. Understanding the factors that are most important to individual colleges assisted in assuring that the processes for selecting technologies for the technology forecasting effort would yield proper import to the needs and desires of the respective colleges.

Survey Methodology

It was determined that the most appropriate participants in the survey would be instructional officers and technical deans throughout Texas community and technical colleges. It was also decided that, where colleges had more than one campus, responses would be requested from all campuses.

Initial survey databases were derived from the THECB list of chief instructional officers and technical deans. These databases were combined to prevent duplication, e-mail addresses were validated for proper format, and community and technical college websites were used to verify first and last names when appropriate.

To encourage participation, the THECB sent a notification letter by mail and e-mail to the survey population. This letter described the survey's purpose and encouraged participation. On July 3, 2002, each proposed participant received a personalized e-mail invitation and a unique link to the online survey from TSTC. Six e-mail addresses were found to be incorrect and, once resolved, a second e-mail notification was sent to these participants on July 10, 2002. On July 11, 2002, a reminder notice was sent by TSTC to those who had not yet completed the survey. The survey was closed on July 16, 2002, and initial analysis was begun.

Of the 69 colleges surveyed, 61 provided valid responses—an impressive 88.4% coverage rate. Moreover, several of the colleges that did not respond reported valid reasons for their non-response, e.g., they had not developed any technology-related programs over the last five years.

Survey Approach

To help gain an understanding of how the colleges have identified and implemented technology-based curricula in the past, the survey asked each participant to select one technology-related program that had been initiated at his or her college in the last five years (Survey Questions 1 and 2). By restricting the survey to one program, it was intended to keep the results from being skewed by colleges that had initiated more programs during the indicated period. Moreover, it was believed that colleges would tend to select the programs that had been most successful. The five-year period was specified to highlight recently-developed programs over older programs. Once the program to be considered was identified, a number of related questions were presented (Survey Questions 3 through 21).

In order to determine the criteria that colleges currently use in selecting programs for development, a second set of questions was presented (Survey Questions 22 through 27).

The results of the survey and their significance are shown in the following sections of this report. (In some cases, where the responses to questions did not show statistical significance nor add significantly to the findings of this report, the analysis is omitted.)

Analysis of Survey Results

Types of New Programs Developed by Colleges of the State (Survey Question 2)

This question was designed to identify the nature of programs developed over the last five years by the individual colleges. The breakdown of programs according to subject matter is shown in Exhibit 1. Detailed descriptions of programs are presented in Appendix C.

Exhibit 1

Title and Classification of Program

Computer-Related
- Help Desk Support Level 1 Certificate
- Business Office Support Specialist
- IT Project Management
- Project Management
- Computer Graphics
- E-Commerce
- Multimedia Web Design
- Network Security Technology
- Cisco I
- PC Desktop Support
- Web Mastery Specialization
- Software Engineering & E-Commerce
- Cisco Networking Academy
- Business Computer Information System
- Geographical Information Systems
- CISCO Academy
- Microsoft Systems Engineer
- Geographic Information Systems
- Computer Maintenance Technology
- Geographic Information System
- Information Technology Technician
- Certified Cisco Systems Networking
- Certified Cisco Networking Systems
- Information Technology Networking
- Micromanufacturing Technology
- AAS in Computer Information Systems
- Computer Networking
- Network Specialist
- Management Information Systems (MIS)

Biotechnology
- Biotechnology AAS and Level I Certificate
- Biotechnology
- Biotechnology
- Biotechnology Program
- Biotechnology

Manufacturing and Equipment
- Construction and Forestry Equipment Technician (C&F Tech) Program
- Machinist/Machine Technology
- Industrial Maintenance
- Industrial Production Technology
- Machine Tool CNC Operator

Miscellaneous
- Veterinary Technician
- Turf Grass Management
- Alternative Teacher Certification

Health Care
- Dental Assisting
- Emergency Medical Services
- Dental Hygiene
- Diagnostic Medical Imaging
- Pharmacy Technology
- Diagnostic Cardiac Sonography
- Respiratory Therapy
- OTA (Occupational Therapy Assisting)
- Pharmacy Technology
- Phlebotomy
- Pharmacy Technology
- Vision Care Technology
- Radiation Therapy
- Histologic Technology
- Emergency Medical Services
- Emergency Medical Services Professions

Transportation
- Automotive Collision Repair Technology
- Aviation Maintenance Technology

Environmental Technology
- Heat; Ventilation; and AC
- Pilot Training
- Auto Body Repair

Energy-Related
- Fuel Cell Technology
- Airframe and Power Technology
- Process Technology
- Process Technology
- Petrochemical Process Technology

Criminal Justice
- Criminal Justice Program
- Criminal Justice
- Basic Correctional Officer Training

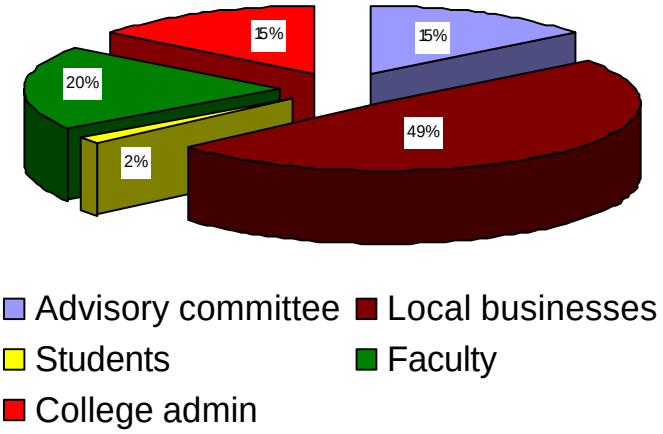
Source: TSTC/TFI New Curriculum Development Survey (July 2002)

Of the 70 programs identified, 39% were computer related and 27% were health-care related. Only a small number of the identified programs reflected forefront areas of technology such as biotechnology, nanotechnology, or new energy sources.

Principal Sources for New Program Selection (Survey Question 3)

This question was designed to identify where interest in new programs originated. The breakdown of principal sources for program selection is shown in Exhibit 2.

Exhibit 2
Origination of Idea for Program



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

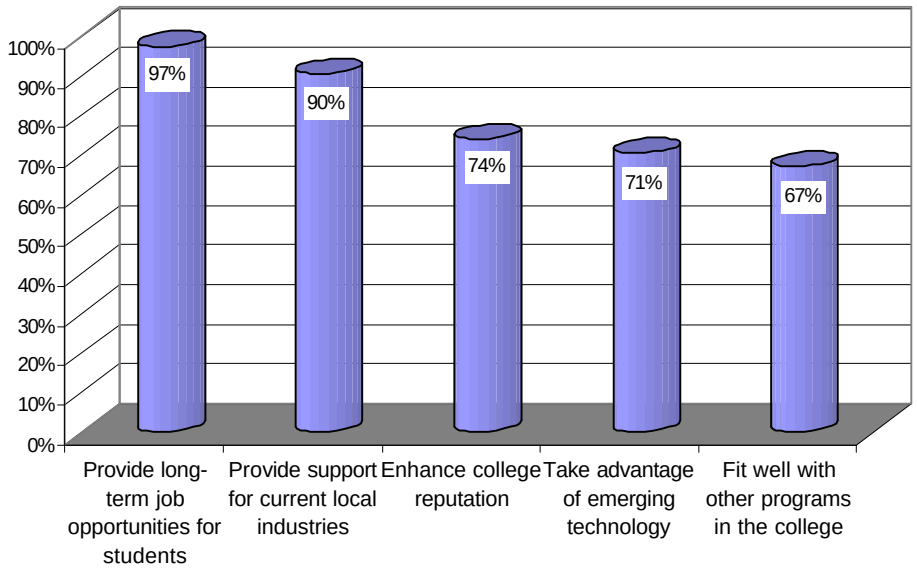
Of the respondents, 49% indicated that the principal source of program suggestions came from local business, and an additional 15% listed local advisory committees as the principal source. These figures reflect the extreme importance of local businesses in identifying new college programs.

Determined the Primary Reason for Interest in New Programs (Survey Question 4)

This question was designed to determine the reasons that motivated the colleges to initiate the selected programs. Exhibit 3 shows the percentage of respondents who listed various criteria as either of "prime importance" or "very important."

Exhibit 3

Top Five Reasons for Interest in the New Program



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

The five most important criteria, in order of importance, were:

- Provide long-term job opportunities for students.
- Provide support for current local industry.
- Enhance college prestige.
- Take advantage of emerging technology.
- Fit well with other programs in the college.

These results reinforce the importance of service to local industry, as well as recognition of the colleges' responsibility to their students. It is also interesting to note that using incentives to bring new industry to the community was not among the top criteria. This may reflect limited interest in adding programs in truly disruptive technologies.

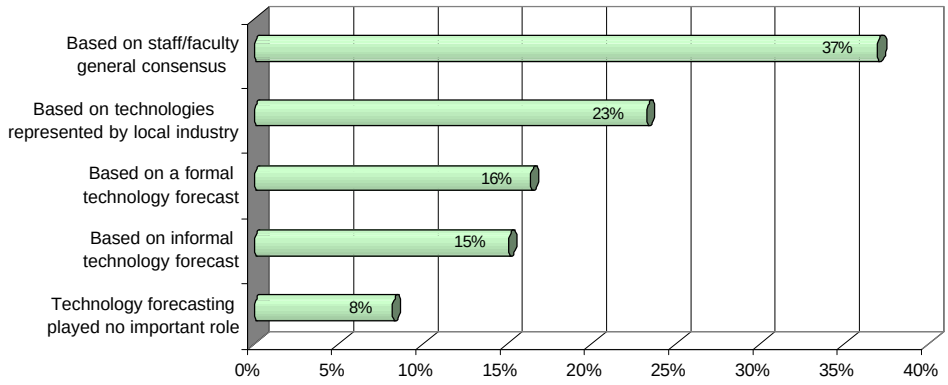
Extent to Which Technology Forecasting is Currently Being Utilized in the Selection of New Programs (Survey Question 5)

This question was designed to determine the extent to which the colleges utilized either formal or informal technology forecasting techniques to assist in the

selection of new technology related programs. The results from this question are presented in Exhibit 4.

Exhibit 4

Role of Technology Forecasting in Program Development



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

Twelve respondents indicated that they had used formal technology forecasting (TF) techniques in selecting the programs that they described, and 11 respondents indicated that they had used informal TF techniques. However, follow-up contacts with some of the respondents indicate that few of these respondents had used techniques such as those described in the TF section of this report, with the exception of informal interviews and group discussions. Therefore, it does not appear that the value of formal TF in program selection, design, and initiation has been truly tested.

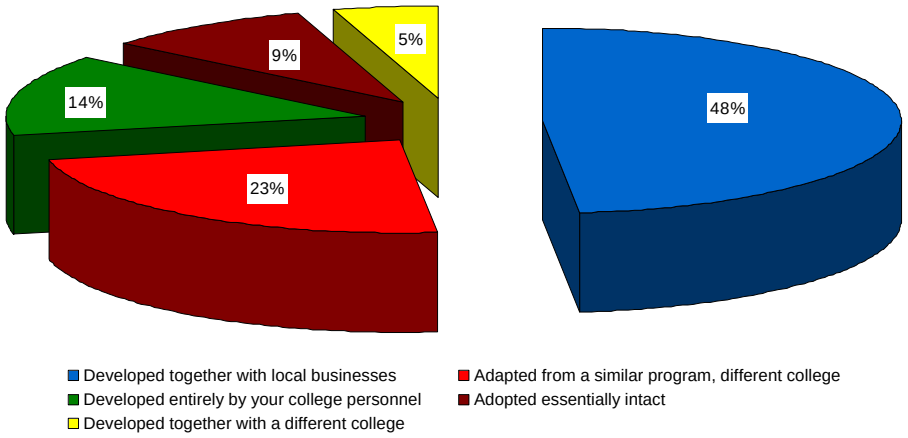
However, this does not suggest that colleges do not have very carefully designed and effective processes for evaluating emerging-technology related programs. Two examples of such processes that were identified in the survey follow-ups are shown as Appendix D.

Extent to Which Colleges Work Together in Developing New Programs (Survey Question 9)

This question was designed to determine the manner in which colleges worked together in the development or adoption of new technology-related programs. The results from this question are presented in Exhibit 5.

Exhibit 5

Method of Program Adoption



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

It should be noted that 38% of the programs were developed in some sort of coordination with other colleges. This indicates that there is currently considerable cooperation between the state's community and technical colleges. Informal conversations with college administrators and faculty indicate that the cooperation will increase in the future.

One should also note the high percentage of programs that are developed in coordination with local industries (48%). This again indicates the importance of local businesses in program development.

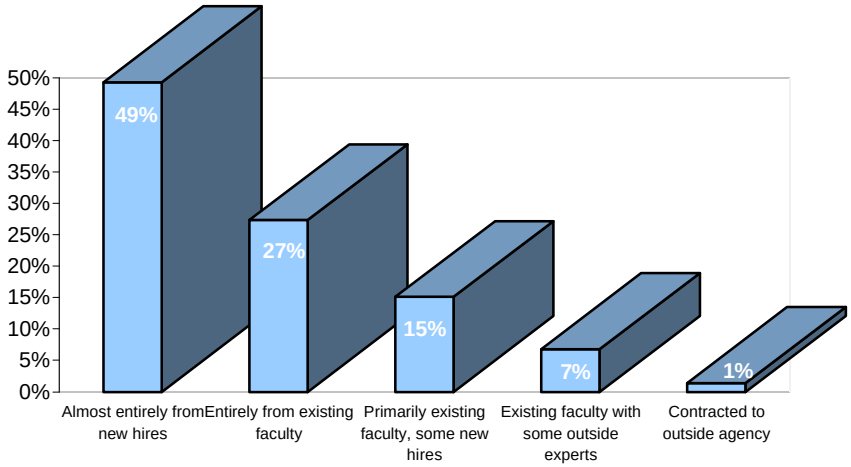
How the Faculty for New Programs Was Most Commonly Selected (Survey Question 10)

This question was designed to determine how the faculty was chosen for the programs. The results from this question are presented in Exhibit 6.

Almost half of the programs required entirely new faculty, and an additional 23 % required some type of current faculty augmentation. These figures strongly indicate that new faculty hires will be required for the development of emerging-technology related programs. This requirement will probably be even more evident as the need for more advanced technology training increases.

Exhibit 6

Faculty Selection for New Program



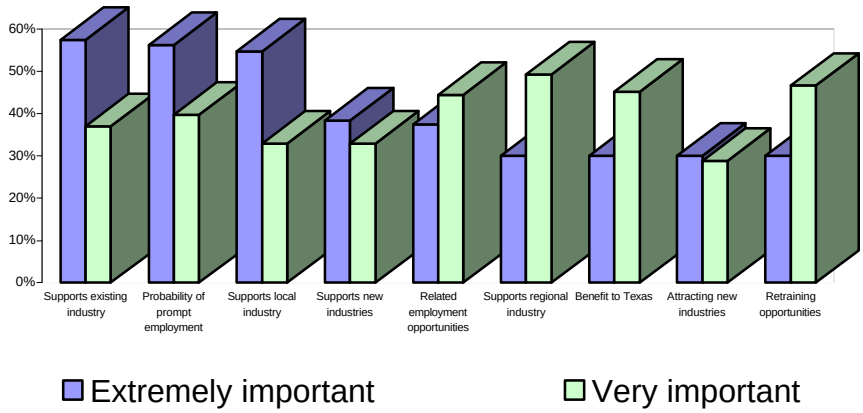
Source: TSTC/TFI New Curriculum Development Survey (July 2002)

Criteria Currently Used to Select New Programs for Development (Survey Questions 22 and 23)

These two questions were designed to determine the relative importance of various criteria in the initiation of new technology related programs. Survey Question 22 asked the respondents to rate the relative importance of a number of listed criteria in program selection. The results from this question are presented in Exhibit 7. Survey Question 23 was more open-ended in asking respondents to identify criteria that were not listed in Survey Question 22. The results from this question are presented in Exhibit 8.

Exhibit 7

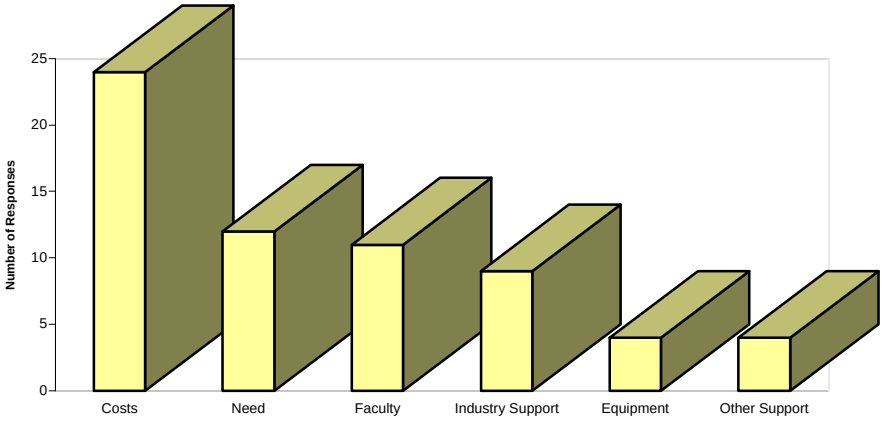
Importance of Criteria for Selecting a New Program Development Initiative



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

Exhibit 8

Additional Criteria for New Program Selection and Development



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

Although the results from this question indicate that all of the listed criteria are of major importance in the new program selection process, the high priority afforded local and existing industries again illustrates the great importance of meeting local industry needs in new program selection. It is also interesting to note the particular emphasis given to "prompt" employment.

As indicated in Exhibit 8, responses fell into six categories: cost of initiating a program, size and urgency of needs, faculty requirements, extent of local support, equipment needed to support new programs, and other support required. Examination of these criteria highlights the particular importance of the cost of

program initiation. This observation is borne out by review of the comments of respondents.

Individual responses included the following:

- Does the college have the funds, facilities, equipment, and human resources to support program development and sustainability?
- Will the program be fiscally sound within five years of inception?
- Is there a job market for program graduates?
- Are there opportunities for community partnership and liaisons?
- Will future employers provide equipment and supplies?
- Will the program represent a strong addition to the overall development of the college?
- Is there strong support from the Advisory Committee?

A listing of all responses is presented in Appendix E.

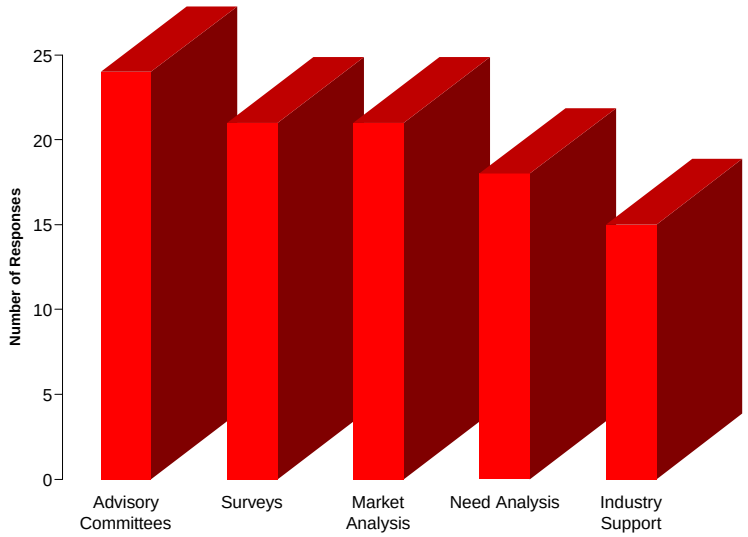
Identified the Methodologies Used in Selecting New Programs (Survey Question 24)

This question was designed to identify the methodologies used in selecting programs for development. The results are presented in Exhibit 9.

When broken down by category, many respondents specifically cited the use of Advisory Boards/Committees to aid in the selection of a new program. However, various research methods were most widely used; 60 responses cited one or more of the following methods: the use of industry and institutional surveys, labor market studies, and needs assessments. This demonstrates that most respondents recognize the need for sound methodology to "back up" their desire or perceived need for a new program.

Exhibit 9

Methodologies Used When Selecting a New Program



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

Specific answers of respondents included:

- Review of advisory board recommendations and regional needs.
- Use of business, industry, government, education, and health-care advisory committees.
- Visioning sessions involving the board, faculty, staff, and community.
- Survey of other colleges.
- Surveys of School Industrial Cooperative Committee membership.
- Anticipation of future job market demand as technology advances.
- National, regional, and local labor market data.
- Cost analysis to see if the program can be afforded.
- Agreement with the college's three-year comprehensive master plan.
- Current trends in industry and corporate sectors.
- Ideas are accepted from industry, advisory groups, faculty, students, administrators, staff, and virtually anyone else.

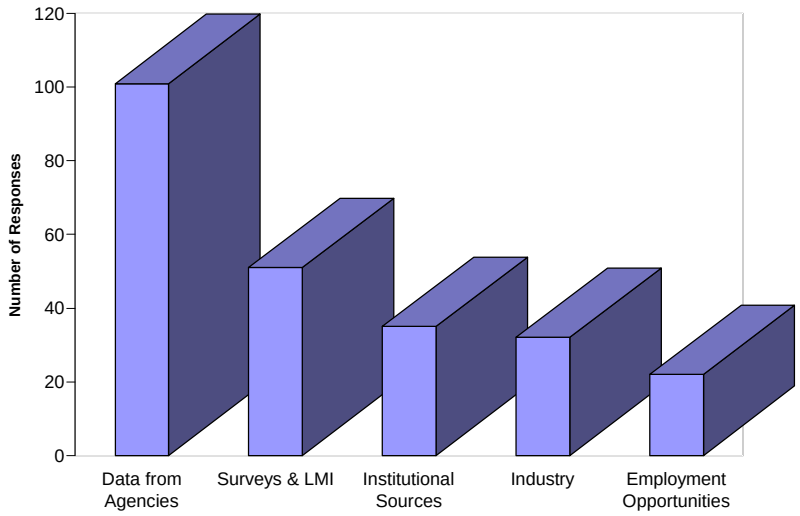
- Establish articulation agreements with area school districts and senior colleges.
- Pilot potential programs through non-credit workforce classes to help assess feasibility of offering program

A listing of all comments is presented in Appendix F.

Sources of Information Used in New Program Selection (Survey Question 25)

This question was designed to identify the sources of information used by the colleges in program selection. The results from this question are presented in Exhibit 10.

Exhibit 10
Sources of Information



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

The majority of respondents cited various agencies—such as the Texas Workforce Commission, the U.S. Department of Labor, and local Chambers of Commerce—as sources of information for selecting programs to develop. Many respondents conducted industry surveys and gathered relevant labor market information as well. The list of information sources included:

- Local, state, national, and international trends and issues.
- Emerging and evolving technological advances.

- Faculty research.
- Formal surveys of local business/industry to determine employment opportunities.
- Newspaper advertisements for job openings.
- Review of National Science Foundation and Advanced Technology Education Centers grant funding.

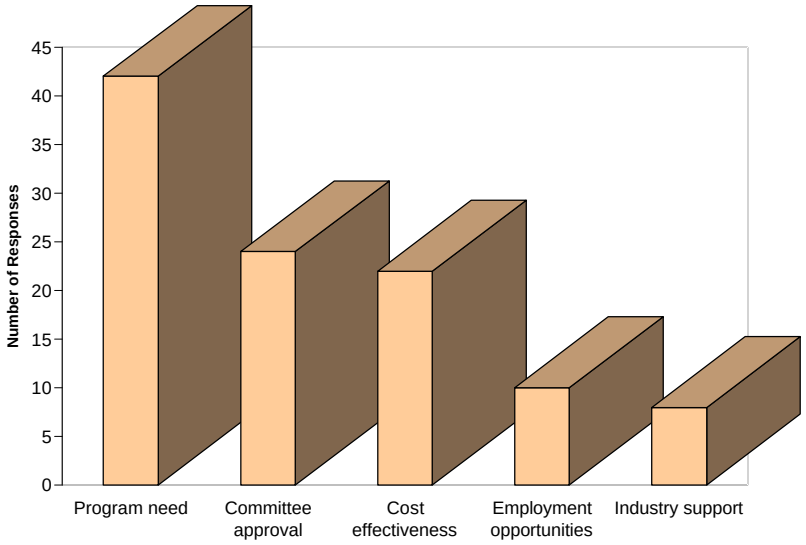
A listing of all respondent comments on information sources is presented in Appendix G.

Validation Documentation Required by the Colleges Prior to Investing in New Programs

This question was designed to determine the types of validation that colleges require before investing in the development of new programs. The results from this question are presented in Exhibit 11.

Exhibit 11

Validation Documentation Required for New Program Development



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

A demonstration of program need—determined primarily through labor market analyses, needs assessments, and local industry surveys—was the primary type of validation information indicated by survey respondents. Committee approval and the program's cost effectiveness were also important for program development. Responses to this question included the following:

- Advice from local business and industry.
- Demand from graduates of the program.
- Positive survey results from supporting industry.
- Documentation of support from advisory committee.
- Response to Letter of Intent from THECB.
- A five-year budget projection plan.
- Start up an ongoing cost assessment.
- Financial support from business and industry.
- Requirement of a mini-business plan.
- Documented evidence of sufficient job opportunities.
- Commitment from local industry to advise all development aspects of the program.
- Assessment of the availability of qualified faculty.
- Assurance of adequate space, facilities, and equipment.

A full list of responses on validation documentation is presented in Appendix H.

Lessons Learned in the New Program Development Process (Survey Question 21)

This question was designed to determine the lessons that had been learned by the various colleges during the development of the selected programs. The results from this question are presented in Exhibit 12.

The lessons learned by the colleges fell into six general categories:

1) The importance of research in determining the desirability of initiating new programs.
2) The importance of industry (usually local) in supporting new programs.
3) The restrictions placed on new program initiation by limitation of qualified faculty.

4) The requirements for adequate funding of new programs.

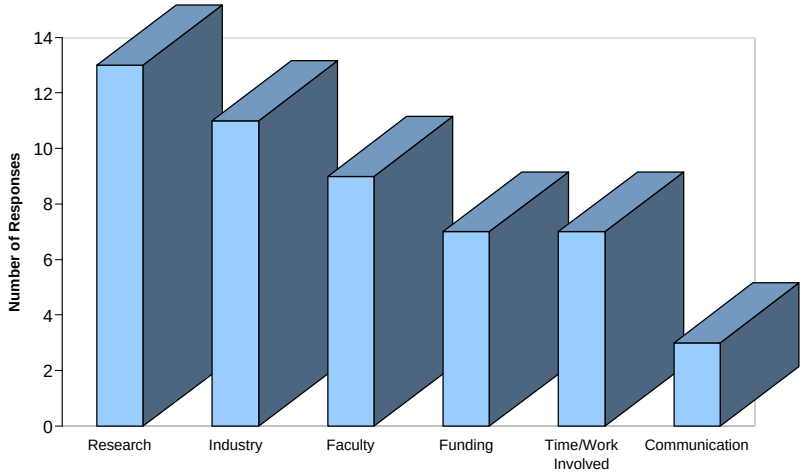
5) The limitations on new program development posed by the time required to initiate such programs.

6) The importance (and difficulty) of establishing effective communications between the parties involved in program development.

A review of Exhibit 12 indicates the importance of careful research in determining the feasibility of initiating new programs, as well as the need for adequate resources for new program initiation.

Exhibit 12

Lessons Learned from Program Establishment



Source: TSTC/TFI New Curriculum Development Survey (July 2002)

Lessons learned included the following:

- Advertising is extremely important for the first program semester.
- Programs based on emerging technologies are expensive but lead to immediate benefits to the graduates.
- It is important to plan to phase the program in over time because the curriculum development process is very complex and time consuming.
- New programs must be marketed. The "build it and they will come" approach does not work.
- The critical time for program implementation has to be based on a combination of demand and awareness of the evolving needs of industry.

- A reliable process for technology forecasting is needed prior to investing in new programs.
- Industry-driven programs command significant support through employment opportunities, innovative professional sharing opportunities, greatly enhanced vendor support, scholarships, internships, student recruiting, and incumbent worker upgrading opportunities.
- Development of acceptable curricula requires total commitment of a content exert. This cannot be an "add-on" responsibility for an existing faculty member.
- New program development is dependent on the availability of funds. Qualified faculty members are difficult to hire for specialized programs.
- Collaborative programs have hurdles to overcome. Communication between partners is vital, but difficult at times.
- A better rapport with local high schools must be established.
- The need for industry-specific Spanish skills is expanding in the health-care field.
- Every constituency must be considered.

The entire list of lessons learned is presented in Appendix I.

Additional Comments of Respondents (Survey Question 27)

This question was designed to gather any experiences, insights, opinions, or comments that respondents wished to offer about the survey, the current project, or other aspects of the program development process. A listing of these comments is presented in Appendix J.

Survey Significance

This statewide curriculum development survey appears to be the first of its kind, and several of the respondents indicated their appreciation for our research into this area and much interest in the compiled results. The analysis section of this report was distributed to respondents, Texas community and technical colleges, the THECB, and a variety of other key stakeholders throughout the state. The high response rate and wealth of information gathered from this survey method was a key component of the mid-year research and development effort, and, since this method was so beneficial, additional survey work was incorporated into the PET methodologies described in the next section of this report.

The TSTC/TFI team would like to thank the THECB, CCD, and all of the respondents for their participation in this survey and the time and effort put into their responses.

Program for Emerging Technologies (PET)

In general, Texas community and technical colleges have logical, well-structured processes for identifying program development needs to meet existing local needs. However, by their nature, these curriculum development initiatives tend to put primary emphasis on current needs. A process for identifying and analyzing emerging-technology program opportunities has been developed based largely on the needs and desires expressed by college deans throughout the state, plus direct input from a smaller representative group of community and technical college deans through coordination with the CCD and the formation of a CCD Forecasting Subcommittee. This process, entitled *Programs for Emerging Technologies (PET)*, is comprised of three essential components:

1) Identifying promising emerging-technology program areas.

2) Conducting meaningful technology forecasts for the identified technologies.

3) Disseminating resulting findings and technology forecasts to the State's community and technical colleges and other curriculum development stakeholders to promote informed and proactive decision making.

PET utilizes existing data sources and targeted surveys to reveal key indicators of promising emerging-technology programs applicable to Texas community and technical colleges. Once identified, outside vendors are utilized to conduct detailed technology forecasts based on the specific needs of instructional officers and other key stakeholders.

It is important to note that PET will undergo additional refinement in the 2003 project year as new data sources are identified and procedures further validated. This information will be collected in a centralized database and distributed online to all key stakeholders.

Identification of Promising Technology Program Areas

There is no crystal ball to predict which of the many emerging technologies available to forecast are likely to have the greatest workforce implications—much less warrant new curriculum development. Since it would be unrealistic and cost prohibitive to conduct forecasts for all of these technologies, a process is necessary

to identify a select number of likely promising technologies for which forecasts should be conducted. PET incorporates a series of emerging-technology program indicators broken into three categories: defined, definable, and undefined. For each of these categories, specific indicators, methodologies, and data sources are identified and explained.

Defined Indicators

The Workforce Education Course Manual (WECM) includes a database of all Texas community and technical college programs, courses, and associated data (i.e., contact hours, locations, etc.). When a college plans to develop a new program, they must first complete the "Application for Approval of New Workforce Education Programs" form located online at the THECB WECM website.[2] The majority of new program applications are not based on emerging technologies, but rather on already-existing programs. However, when an emerging-technology program application is created, this will be a defined indication of a new technology program need. Program revisions based on emerging technologies are also valuable defined indicators of new program needs. In both cases, this data is stored and readily available in the WECM database.

Definable Indicators

Anticipated new programs, scientific research, and economic development efforts throughout the state can indicate impending new technology program needs. Although these sources are less clearly defined than actual new programs, they are definable indicators. For example, if a significant number of instructional officers are planning to implement the same new emerging-technology program next year, there are numerous research activities and grants in the same area, and economic development corporations confirm increasing activity in the corresponding industry sector, there is a definable indication that this is a promising technology program area and additional in-depth forecasting would likely be beneficial.

In order to determine anticipated new programs, PET employs targeted surveys of curriculum development officers throughout the 69 Texas community and technical colleges. R&D funding can also be an early indicator of new emerging technologies, and the RAND Radius database helps provides insight into federally funded areas of scientific research and development. Targeted surveys of Texas engineering schools may also be employed to localize these R&D efforts and help identify key stakeholders in promising technology sectors. Texas economic development corporations and chambers of commerce will also be surveyed. These surveys are now under development and will be tested with focus groups before full implementation.

[2] See http://www.thecb.state.tx.us/ctc/ip/wecm2000/main.htm.

Undefined Indicators

Future trends, technology, and events can be difficult and sometimes impossible to predict, but they can also provide strong indications of impending workforce and curriculum needs. For example, trends in wireless networking indicate that continuous networking will be a reality in the coming years, recent technological advances in fuel cells and successful prototypes demonstrated by General Motors have made the long-awaited entry of consumer automobile PEM fuel cell stacks a foreseeable reality,[3] and increased security concerns resulting from September 11 have resulted in a flood of new grants and research in the defense and security sectors. These undefined indicators are unpredictable, and there is no single data source to rely upon, but these can be strong indications of an emerging technology trend and future impending workforce and curriculum needs. Beside typical news and information sources, futurist-oriented publications such as *The Futurist*, MIT's *Technology Review*, and several others can provide early insights into emerging technology trends. Additional reliable sources will be identified and categorized in subsequent program years. This component of PET is represented in the following exhibit and a graphic representation is included as Appendix K.

Exhibit 13
Identifying Promising New Technology Program Areas

	Indicators	Data Sources	Methodologies
Defined	New/Revised Programs: AAS, ATC, Certificates, LN, ST	Workforce Education Course Manual (WECM)	WECM SQL Database Existing Data
Definable	Anticipated New Programs	Instructional Officers Technical Deans	Survey Data
	Scientific Research	Schools of Engineering Research Funding Areas	Survey Data RAND Radius Database
	Economic Development Efforts	Blue Ribbon Task Forces Economic Dev Corporations Chambers of Commerce	Existing Data Survey Data
Undefined	Future Trends, Technology, & Events	Industry Leaders, Futurists Scientific Research Government Programs	Literature Reviews

Source: TSTC

[3] General Motors, *GM Hy-wire: Major Step Forward In Reinventing Automobile* (2002).

When the list of promising technology areas has been completed, a select number (six to eight) of specific technology areas will be identified for which technology forecasts will be conducted. This selection will be made by the PET team based on consideration of a number of weighted criteria. In general, criteria will be chosen and weighted in such a manner as to give special importance to areas of technology that offer particular promise of increasing, long-term growth and positive economic impact for the State of Texas. The list of criteria will include those identified in the recent survey, such as:

- The technology is likely to provide a meaningful number of well-paying jobs to two-year college graduates within two to four years.
- The expected workforce demands related to the technology are likely to increase steadily and significantly in the four- to eight-year time period.
- New curricula will be necessary to ensure that impending workforce demand will be satisfied.

Modifications to the Selection Process

Additional criteria will be identified by the PET team and other appropriate college, government, and business groups, and it is likely that sources and methodologies will be revised and updated as new or more effective data sources become available and are incorporated into PET.

Although the preceding paragraphs describe a structured process for technology selection, it is not envisioned that it will be applied mechanically. When appropriate, logic and independent judgment may replace formal methodologies. For example, an obvious emerging technology sector may be identified and selected for forecasting at any point in the program year, while, in other cases, it may become apparent that a previously identified promising technology is, in fact, unlikely to warrant new curriculum development, and research resources will be directed to other areas.

Results

In order to begin the forecasting activities earlier in the project, two technology areas will be selected that appear to be particularly attractive based on PET. TFs for these technologies will then be initiated immediately by an external forecasting vendor. The TSTC/TFI team has developed a detailed RFP and sample statement of work to guide vendors in the bidding process. This will ensure a broad range of forecast proposals and ensure the project does not depend entirely on a single vendor.

As described above, the identification process included in PET involves logical, structured, transparent mechanisms that can be moderated by logic. It is envisioned that this process will result in the selection of six to eight technologies that offer very promising opportunities for the success of the community and technical colleges of Texas and the economic wellbeing of the State. The next phase of PET involves the conduct of detailed technical forecasts based on these results.

Technology Forecasting Process

Purpose of Technology Forecasting

The fundamental purpose of formal technology forecasting is to project the nature, timing, and implications of advances in technology. The value of technology forecasting in assisting in the identification, design, and initiation of emerging-technology programs for Texas community and technical colleges will involve all three of these elements.

The importance of defining the nature of technology advances is obvious, for this will identify those areas of technology that have the highest probability of providing profitable opportunities for the businesses of the State.

The timing of the advances is also of major importance for colleges. If courses are presented too early in the technology development process, graduates will not be able to find suitable employment. If the courses are offered too late, the special advantages of early entry into a burgeoning field will be lost, and the workforce needed to support these technologies may not be available.

Finally, the implications of emerging technologies must be projected. In a society as complex and interactive as ours, new technologies have indirect and often unexpected impacts and consequences. The recognition and appreciation of these impacts and consequences will support better decision making with regard to effective curricula development and implementation.

Forecasting Tasks

Based on the identification process described in the previous section, six to eight formal TFs will be conducted as the second phase of PET. A forecasting agent with extensive experience in technology forecasting will be engaged to conduct formal TFs in each of the selected technologies. These TFs will be specifically designed to provide the colleges with insights and information that will be useful

in identifying and initiating new technology related programs. Each of these TFS will involve the following tasks:

- *Project the state of the art*. This task will involve projections of the manner and timing in which advances in technologies will occur. This effort will not only project how the basic characteristics of each technology will change over time, but will also identify possible spin-off technologies and novel uses of the technologies.

- *Project market potential*. This task will involve projections of potential market size for the new technologies, as well as analysis of how rapidly these markets will develop. Where appropriate, market segmentation and special conditions will also be examined.

- *Target Texas*. Of necessity, the first two steps must consider nationwide, and even worldwide, projections. However, for the purpose of PET, the implications of these technology and market developments for Texas are of primary interest to the people and industries of the State. Therefore, the broader projections must be targeted to the particular situations existing in Texas.

- *Validate analysis*. When the preceding tasks have been completed, it will be necessary to validate the results of the forecasting process. This validation must not only include an evaluation of the quality of the forecasts, but also the extent to which they are of value to the potential users involved. One of the most important elements in the use of technology forecasting is the confidence that potential users have in the validity of the forecasts. This task will be conducted in such a way as to support that confidence.*Identify opportunities*. To achieve the objectives of PET, the TFs must be translated into information and insights that will assist the Texas community and technical colleges in identifying, designing, and initiating emerging-technology programs that will promote the economic wellbeing of the State. A part of this effort will involve an examination of the relationship between the selected emerging technologies and the specific employment opportunities they will offer.**Planning the Technology Forecasts**

A successful TF must be based on a logical, carefully considered plan. Listed below are the basic steps that should be included in any TF project plan. Although these elements are arranged in roughly sequential order, in reality, several of the elements must be considered simultaneously or iteratively.

Objective—The objective of the TF project should be defined in clear, concise terms. The new information and insight that the TF is expected to provide should be specifically identified. For this project, the objective has been defined as providing information and insights that will assist colleges in selecting, designing, and initiating emerging-technology programs that will enhance and expand the economic well-being of the State.

Schedule—Since the TF is being conducted to assist in decision making, final and interim results must be available in time to be useful. In PET, the TFs are to be completed during the second, third, and fourth quarters of the project year.

Scope—The TF plan must consider both the breadth of subject areas to be considered in the TF and the resources that will be made available to the project. In general, for a given level of effort, the more limited the scope of the forecast, the more detailed the forecast can be.

Approach—Early in the planning process, the approach or approaches to be used in the project must be determined. The approach to be used in this project is discussed later in this section.

Project Resources—Once the scope and approach of the project have been determined, specific assignment of resources should be conducted. As indicated earlier, the major portion of the forecasting effort will be the responsibility of the forecasting agent.

Project Organization—For the project to be conducted efficiently, organizational details must be specified. Details might include responsibilities of project personnel, reporting procedures, and administrative details. These details are either discussed in other parts of this report or are defined by various government directives.

Techniques—At this point, the particular techniques to be utilized in the study should be chosen. It is important to specify the contribution that each technique is expected to make to the overall forecast. One should also consider how the results from the different techniques will be correlated and/or combined. As the project continues, the mix of techniques can be modified as appropriate.

Evaluation Criteria—At the end of the project, its effectiveness and cost/benefit ratio should be evaluated. The PET team will be responsible for developing suitable criteria for evaluating the success of each individual forecast.

Forecasting Techniques

Depending on definitions, there are between 40 and 100 practical, proven techniques that can be employed in conducting TF projects. The most commonly

used techniques can be usefully classified into five categories of forecasters: extrapolators, pattern analysts, goal analysts, counter punchers, and intuitors. Each technique has its own strengths and advantages, but experience has shown that the most valid results are achieved when two or more of the techniques are used in concert. In Appendix L, the rationale supporting each of these five categories is presented, together with a listing of the methods and techniques associated with each category and an analysis of the key characteristics of each category.

The specific approaches, methods, and techniques that will be utilized to accomplish the previously listed tasks will depend on the specific situation involved in each forecast. Factors that will influence the selection of methods and techniques include the availability and quality of data, the desires and requirements of potential users, and the time and resources available for the conduct of the forecast.

Data Sources

A key element in the conduct and utilization of the TFs will be the collection and evaluation of data. College officials will not act on forecast results unless they are convinced that the forecasts are based on credible data treated in a logical manner. The terms "credible" and "logical" must reflect the beliefs of those who will use the results of the forecasts.

Successful accomplishment of the PET objectives will require an enormous amount of reliable, timely, and applicable data. Therefore, one of the key activities of this project will be the determination of the types of data that will be required and the identification of potential sources from which to gather this data. The data needed can be classified into three categories:

- *Previously collected and evaluated data*, such as types and size of State industries, current production figures, industry growth rates, and employment statistics. This data will be gathered primarily from existing records, databases, and appropriate publications.

- *Data involving projected developments*, such as planned growth of current State industries, expected new State industries, and related employment opportunities. This data will be gathered from published company reports, individual interviews, group meetings, and structured surveys of people who will be involved in decision making in the relevant industries and/or who are knowledgeable about developing trends.

- *Data involving a broad view of future technological possibilities*. This data will be used to identify disruptive technologies that might otherwise be overlooked. This data will be gathered from existing literature and interaction with future-oriented organizations and individuals. Periodicals

that will be utilized include *The Futurist*, *Technology Forecasting & Social Change*, *Scientific American*, *Science News*, *Technology Review*, *Technology Research Management*, and *Catalyst*. Books, such as *Engineering Tomorrow* by Janie Fouke, *The Virtual Corporation* by William Davidow and Michael Malone, *The Age of Unreason* by Charles Handy, *The Experience Economy* by Joseph Pine and James Gilmore, *Chemistry and Life Science: Visions of the Future* and *Physics and Electronics: Visions of the Future* both by Michael Thompson, and *Future Perfect* by Stanley Davis will also be used.

Personal discussions will be conducted with technology practitioners, such as university professors, technology news editors, and government officials, in appropriate agencies such as the National Science Foundation, the National Aeronautics and Space Administration, and the National Institutes of Health. In addition, prominent futurists will be consulted, such as recognized experts like Dr. Peter Bishop (Director, Futures Research Program, University of Houston at Clear Lake), David Snyder (President, Snyder Family Enterprises, a Washington, D.C., futures research organization, and co-author of the soon-to-be-published paper *The Strategic Context of Education in America: 2000–2020*), and Joseph Coates (former President of Coates and Jarrett, a Washington, D.C., futures research organization and co-author of *2025: Scenarios of U.S. and Global Society Reshaped by Science and Technology*).

Conduct of Technology Forecast Tasks

Project State of the Art

This task will involve definition of the current state of the technology, projection of how the technology will advance in the future, analysis of the implications of the advances in technology, and identification of possible technology spin-offs. The first step in this process will be to identify the key parameters for each technology, e.g., speed, weight, capacity, versatility, purity, and/or cost. When these key parameters have been identified, the current status of each parameter will be determined.

The next step in the process will be to project possible advances in the technologies. Various TF methods and techniques will be used to accomplish this end. One technique that might be used is *Technology Trend Extrapolation*. Experience has shown that, for most emerging technologies, key parameters follow an exponential improvement pattern. Thus, in using this technique, the forecasting agent will investigate past advances in the technology and search for identifiable patterns of progress. If such patterns can be identified, they can be extrapolated to project future advances. Observations that might indicate that technical change is imminent include:

- Changes in technical or economic performance.
- Changes in personnel and facilities.
- Funding announcements.
- Paper and meeting topics.
- Technical demonstrations.
- Program reports.
- Patent awards.
- New sales and advertising programs.

Another approach that might be applied to the projection effort is the use of *Precursor Trends*. Through the years, forecasters have found that developments in certain technologies follow a lead-lag relationship. For example, for several decades, new technologies developed for racecars have appeared in luxury production cars about four years later, in medium priced cars three years after that, and in inexpensive cars after another three years. To determine if this method can be useful, the forecasting agent will seek to identify any historic ties between the technology under consideration and some other related technology. If such a relationship can be identified, the forecasting agent may be able to project the state of the art in the lagging technology at some future point in time by observing the current state of the art in the related leading technology.

Another technique that might be used is *Analogy Analysis*. Experience has shown that patterns of progress are often repeated in different, but similar, technologies. For example, one could reasonably project advances in high-definition television, or even three-dimensional television, by examining the history of color and black-and-white television. In this project, the forecasting agent will seek to identify analogous technology development patterns and apply these patterns to emerging technologies.

Among the questions to be asked during this part of the TF project are the following:

- Where in the development process is the technology now, i.e. discovery/ concept, laboratory demonstration, field trials, or early commercial trials?
- What steps must still be completed?
- How long does it usually take to go from here to commercialization? Can and will they be compressed?

- Who is currently working on the technology?
- What problems are likely to occur?
- How fast can these be overcome?
- Are there parallel developments in progress?What are the required conditions for commercial success?As the forecasting agent is in the process of projecting future technical advance, a series of *Impact Wheel* and *Nominal Group* analyses can be conducted to add depth to the TF process. *Impact Wheel* analyses are structured to uncover unexpected and/or unintended consequences of new technology advances. In this technique, an advance in technology is postulated. The direct impacts of this advance are then identified. Next, the secondary impacts, i.e., impacts caused by the identified direct impacts, will be identified. This process is continued to identify tertiary and other higher-order impacts.

Nominal Group analysis is a specially structured method for utilizing the knowledge and insights of a group of experts through identification of key issues, discussion of these issues, and evaluation of the relative importance of these issues. In this part of the forecasting activity, nominal group analysis can be used to identify and evaluate exogenous factors that might impact advances in the targeted technologies. These analyses can also be valuable in identifying spin-off and follow-on technologies. Groups that might be involved in these analyses include:

- Members of TF Subcommittee of the CCD.
- Deans and other members of the community and technical college communities.
- Appropriate State agencies.
- Industry associations.

Project Market Potential

As the forecasting agent projects advances in technologies, it will also project how the market for the technologies will develop. The basic questions to be addressed are how large the market will be for that technology and how rapidly the market will develop. Related questions include:

- Will the technology be adopted by the market?
- How big is the potential market?

- When will the technology be commercially available?
- How fast will the technology penetrate the market?
- What are the factors of success?
- How long before the technology is obsolete?One of the most important steps in projecting market status is the division of the market into its various segments. Often, growth will be different for different market segments. Therefore, the questions indicated above will have to be applied individually to each segment.

Fisher-Pry and *Gompertz Substitution* models can often be used to project the rate of market capture. The former has proven quite accurate in projecting market capture in manufacturing and industrial areas, while the latter has proven more accurate for projecting capture in consumer product areas. Each technique utilizes an exponential curve to project how rapidly an emerging technology will be adopted in the marketplace. Experience has shown that:

- Both techniques can give a general indication of the rate of market adoption after only 1% market capture.
- 5% capture indicates that the emerging technology will eventually take over all of the market for which it is appropriate.
- Projections after 10% capture are reasonably accurate, although sometimes over-optimistic.
- Projections made after 20% capture are typically very accurate.

Input data for these substitution models will be gathered from the sources indicated above.

A number of secondary resources may also be used in projecting changes in the market status. For example, Infotechtrends.com gathers forecasts of market takeovers for a number of technologies. The Gartner Group and a number of other consulting organizations produce market forecasts in a number of technology areas. Moreover, in most industrial areas, there are commercial groups that gather market data on either a continuing or periodic basis.

Target Texas

By their nature, the projections described above involve national or even global trends. Because, however, the purpose of this project is to enhance and expand the

economic wellbeing of the State of Texas, the overall projections must be tailored to reflect the situation in Texas. These projections will involve:

- Growth of industries currently located in Texas.
- The movement of key industries into the State.
- The development of new industries within the borders of the State.
- The establishment of mutual relationships between Texas industries and those of other states or countries.

It is envisioned that this step of the TF process will involve a series of interactions with knowledgeable people through *Structured and Unstructured Interviews*, *Nominal Group* analysis, and *Impact Wheel* analysis. Individuals, groups, and organizations that may be involved in this process include:

- Federal, state, and local government groups.
- Industry associations.
- Individual company executives and planners.
- University faculties.
- Advisory groups.
- College faculty and administrators.
- Labor unions.

Validate Analysis

The next task in the TF process will be to validate both the processes and the results of the forecasts. Potential shortcomings in these areas may include:

- The use of inaccurate or outdated input data.
- The use of improper forecasting procedures.
- Failure to properly evaluate exogenous factors.
- Failure to appreciate higher-order impacts and implications of technological advances and market development.

Constant vigilance will be necessary to reduce the probability of any of these shortcomings. Because of the number of data sources that will be utilized in the project, it is believed that the probability of using inappropriate data will be minimized. In like manner, the use of a number of different forecasting methods and techniques should minimize the probability of improper forecasting procedures.

Two techniques will be used to identify and evaluate exogenous factors. The first will be a specially structured *Nominal Group* analysis in which a number of knowledgeable people who are familiar with the technology being forecast will be asked to identify trends, events, and decisions that might affect the individual forecasts. The group will then be asked to evaluate the importance of these factors in terms of importance, probability of occurrence, and time of occurrence.

The second method for analyzing exogenous factor will be the use of a *Stakeholder Analysis.* In this analysis, the individuals and organizations that will be impacted by the advances in technology or who may impact these advances will be identified. Next, the nature of their interest, their potential reactions, their ability to influence developments, and their commitment to their positions will be defined. Finally, all of these factors will be considered in concert to evaluate what the combined impact of these stakeholders might be.

Finally, to examine the impacts and implications of the projected advances in technology, additional *Impact Wheel* analyses will be conducted using the individuals and organizations indicated in previous parts of this section.

Identify Opportunities

The overall success of PET will be determined by the extent to which it assists the State's community and technical colleges in the identification, design, and initiation of emerging-technology programs that contribute to the economic wellbeing of the State and the long-term employment success of college graduates. Specifically, the types of information that can be expected from a carefully designed and conducted TF include the following:

- Clear definition of the nature of the technology considered.
- Projections of probable advances in each element of the technology.
- Projection of the rates at which these advances will occur.
- Definition of potential follow-on technologies.
- Projections of how large the market for the emerging technology will be and how that market will develop.

- Identification of the companies currently involved in the manufacture, distribution, operation, and maintenance of similar or related technologies.
- The implications of the advances in technology and development of market requirements to the State of Texas and associated groups.
- Identification of trends, events, or decisions that might serve as drivers or constraints on the projected advances in technology, development of markets, or implications of these advances and developments.

Once these elements of the TF have been completed, the results can be used to determine:

- Titles and definitions of potential jobs.
- Number of jobs that will be created by position, time, and location.
- Salary ranges for these jobs.
- The knowledge, skills, and abilities required for the various jobs.
- Required faculty credentials.
- Type and amount of equipment that will be required.
- Facilities that will be required.

Technology Forecasting Example

A TF on biometrics conducted by TFI in 1998 for the In-Q-Tel Corporation (then, In-Q-It) is attached as Appendix M. Although the forecast is somewhat dated and was not developed to support curriculum development, it can serve as an example of how a TF might be used to provide the types of insights and information listed above. The first part of the biometrics TF includes the following elements:

- A general explanation of the principles and purpose of authentication processes.
- A discussion of the tasks required in biometrics authentication.
- A detailed description of biometrics techniques that are based on physiological characteristics.
- A detailed description of biometrics techniques that are based on behavioral characteristics.

The value of this part of the TF to community and technical colleges is that it provides them with an understanding of the various techniques that might serve as a basis for new technology-related programs. The next part of the TF provides a review of the current status of biometrics technologies, including:

- A review of the off-the-shelf systems currently available.
- A comparison of the strengths and weakness of the various systems.
- Projection of future market growth of the various systems.
- A listing of the companies currently offering products in each of the different biometrics systems.

This value of this part of the TF to community and technical colleges is that it provides them with a basis for evaluating the relative attractiveness of programs based on the various biometric systems. This information will also useful in determining which type of program would be most appropriate, e.g., an associate degree program, an advanced technical certificate program, or a local needs program. Moreover, the identification of companies offering products will provide a means for evaluating potential employment opportunities.

The final part of the TF projects more strategic industrial and technology trends. An appreciation of these trends will provide both community and technical colleges and State government agencies with a more strategic view of the future employment opportunities afforded by each biometric system.

Use of Technology Forecasting

An examination of the biometrics TF can illustrate how a TF of this type could be used to assist community and technical colleges in the identification, design, and initiation of new technology-related programs.

To begin with, a review of the "Dynamic Growth" section would have indicated that biometrics promised to be an area of rapid market growth, i.e., "one of the top ten emerging technologies for 1998." This would, in itself, indicate that the area was worth more detailed investigation. (The events of September 11, 2001, increased market attractiveness of authentication systems. Although the TF did not envision this particular undefined event, it did note the public's increasing interest in security systems.)

An examination of the types of biometrics approaches being investigated, together with the current state of the art of each, would have provided a basis for determining the times at which each technology would become attractive. For example, in 1998, fingerprinting was a well-established biometrics technique,

although there was some interest in more advanced techniques, such as chip-based systems. At that time, iris recognition, although not widely used, was gaining acceptance and interest as an authentication system. Other systems, such as keystroke dynamics, gesture analysis, and voiceprints, were being considered for authentication; however, their development and acceptance appeared to be well in the future. Based on these analyses, the community and technical colleges would have been able to determine which of these approaches best suited program development at their institutions.

An understanding of the different technologies involved could have served as a basis for identifying the types of jobs that would be involved in each technology and the skills, knowledge, and abilities required for each. This understanding could have also provided a basis for determining the geographic distribution of employment opportunities. For example, each of the defined biometrics systems will have similar types of jobs. These will involve research and development, manufacturing, installation, operation, and maintenance. The nature of these activities will vary between systems, but, in general, one would not expect research and development activities to provide many job opportunities for two-year college graduates, and manufacturing employment opportunists would typically be locally concentrated. However, the determination that installation, operation, and maintenance opportunities would be widespread could be of interest to colleges throughout the State. The skill levels, and consequently the pay levels, involved in each of these activities would differ.

Identifying companies offering products in each of the biometrics areas would have provided the colleges with a vehicle for examining specific job opportunities, skills, knowledge, and abilities requirements and probable salary ranges.

Next, an analysis of the factors listed "Industrial Trends" and "Technology Trends" would have provided the colleges with a more strategic view of the longer-term employment opportunities. For example:

- The emphasis on reducing the cost, size, and scanning and processing times defines the parameters that could be used to identify significant technical trends in each system.

- The increasing standardization in the biometrics industry indicated that a key step in the market development process was being achieved. This promised more rapid system acceptance.

- The movement toward integration promised more stability in the industry and, hence, more stability in employment opportunities.

- The recognition of the need for public acceptance of the various authentication techniques pointed out the necessity of consideration of

non-technical factors in analyzing the attractiveness of the various authentication techniques. This factor indicated that the less obtrusive systems would have greater market acceptance. (Public acceptance of authentication increased after the events of September 11, 2001.)

- The increasing number of multiple authentication techniques could have resulted in new desirable skills, knowledge, and abilities required for meaningful employment.

- The observation of rapid growth in the smart card industry highlighted an area that might be of particular interest to the colleges.

Finally, the list of "Interesting New Technology Developments" could have called attention to a group of technologies, such as holographic fingerprinting, facial thermographs, hand veins, and layered biometrics verification that merited consideration for the future, but did not promise employment opportunity in the timeframes of interest to community and technical colleges.

Beyond the potential value of valid TFs to the public two-year colleges listed above, experience has shown that the conduct and analysis of a well-planned and executed TF typically afford a number of ancillary values. For example:

- The TF often provides special insights into the less obvious aspects of the technology under consideration.

- The gathering of input data often results in the establishment of special relationships with people active in the industry.

- The identification of interest in a given technology often produces new data sources that might otherwise be restricted or overlooked.

Overall, the conduct of the technology identification and technology forecasting activities embodied in the Programs for Emerging Technologies (PET) process promises to provide powerful support to the community and technical colleges of the State in the identification, design, and initiation of highly promising new emerging-technology related programs.

Practical Application of PET

The purposes of the reported project were twofold:

1) To develop a process for identifying emerging technologies that could effectively contribute to the economic well-being of the State of Texas.

2) To conduct technology forecasts (TFs) based on these technologies that would be useful to the community and technology colleges of the State in determining whether new programs based on these technologies should be designed and initiated, and, if so, how this could be accomplished.

Programs for Emerging Technologies (PET), as described in this report, was developed during this project.

To test the appropriateness of PET, an analysis was conducted on how a specific TF, conducted earlier and for a different purpose, might have been used by colleges to assist in new program identification, design, and initiation. This analysis indicated that the TF could have been of significant value to the State's public two-year colleges. However, to be convincing, the value of PET must be demonstrated in actual application. Hence, the next step in meeting the requirements of Senate Bill 1819 will be to demonstrate and evaluate the usefulness of PET.

To accomplish this task, the PET team will select two emerging technologies that show promise in contributing to the State's wellbeing and in providing attractive employment opportunities for graduates of the State's community and technical colleges. As stated earlier, a forecasting agent with extensive experience in technology forecasting will be engaged to conduct formal TFs in each of the selected technologies. These TFs will be specifically designed to provide the colleges with insights and information that will be useful in identifying and initiating new technology-related programs. These insights and this information will address such issues as the nature and rate of technical advances, the size and growth pattern of related markets, and potential employment projections, such as the number and nature of new jobs created, probable salary ranges, and the faculty, equipment, and facilities that will be required to initiate new programs.

It is anticipated that the conduct of these two forecasts will require approximately three months. During the conduct of the TFs, actions and procedures will be carefully documented, analyzed, and recorded. Upon completion, the TF results will be carefully examined to determine the overall effectiveness of PET and to identify means of improving the process. This examination will involve the State Leadership Consortium for Curricula Development (CCD) and other interested organizations, as appropriate.

Assuming that the validity of PET is supported by the described analysis, additional emerging technologies will be identified and TFs conducted during the remainder of the fiscal year. At the end of these activities, PET will again be examined. A final report on the results of PET, the value of the process to State

community and technical colleges, and recommendations for sustainability and future applications of the process will be completed and distributed to the Texas Higher Education Coordinating Board (THECB), CCD, and other key stakeholders.

The 2003 PET implementation phase will be supported by a Carl D. Perkins Grant administered by the THECB.

A

Senate Bill 1819, 76th Legislature

AN ACT relating to the identification of technical education programs that are needed to maintain and improve the state's economic and technological competitiveness.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF TEXAS:

SECTION 1. Subchapter C, Chapter 135, Education Code, is amended by adding Section 135.61 to read as follows:

Sec. 135.61. FORECASTING TECHNICAL EDUCATION PROGRAM NEEDS.

a) The board shall develop and administer a program to forecast the types of technical education programs that are needed to maintain and improve the state's economic and technological competitiveness.

b) The program shall review the state's business and industry workforce needs for trained and educated workers and suggest specific technical education programs in specific areas that are needed to ensure or that would enhance the state's economic and technological competitiveness. The board may recommend the creation of new technical education programs or new methods of delivering technical education programs.

c) The board shall provide information and recommendations developed under the program to any institution of higher education, as defined by Section 61.003, that:

    1) provides technical education programs; or

    2) the board determines should offer technical education programs for the purpose of Subsection (a).

SECTION 2. The importance of this legislation and the crowded condition of the calendars in both houses create an emergency and an imperative public necessity that the constitutional rule requiring bills to be read on three several days in each house be suspended, and this rule is hereby suspended, and that this Act take effect and be in force from and after its passage, and it is so enacted.

_____ _____

President of the Senate Speaker of the House

I hereby certify that S.B. No. 1819 passed the Senate on May 17, 1999, by the following vote: Yeas 30, Nays 0.

_____

Secretary of the Senate

I hereby certify that S.B. No. 1819 passed the House on May 25, 1999, by the following vote: Yeas 145, Nays 0, two present not voting.

_____

Chief Clerk of the House

Approved:

_____

Date

_____

Governor

B

Curriculum Development Survey

Thank you for participating in this survey.* The results of this survey will be used as input to a program being developed to assist public two-year colleges in Texas in selecting new programs that will better meet the needs of the colleges, their students, and the industries of the state. Participants will receive a summary of results based on the contact information provided at the end of the survey.

The following questions seek information on how the various colleges in the state are currently, or have historically, selected and initiated new programs. This information will be useful in identifying those processes that have been successful and why they have been successful.

Please select one technology-oriented program of instruction initiated by your college within the last five years. For this program, please provide the following information.

1) Title of Program:

2) Brief description of program:

3) Where did the idea for the program originate:

- ☐ Suggestion by advisory committee
- ☐ Suggestion by students
- ☐ Suggestion by faculty
- ☐ Suggestion by college administration
- ☐ Suggestion by local businesses
- ☐ Other

If you selected other, please specify:

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* *Source*: Texas Community & Technology College Curriculum Development Survey (July 2002).

4) Reasons for interest in the new program:

	Primary Reason	Very Important	Moderately Important	Limited Importance	No Justification
Provide long-term job opportunities for students	☐	☐	☐	☐	☐
Provide support for current local industries	☐	☐	☐	☐	☐
Encourage new industry to locate in local area	☐	☐	☐	☐	☐
Take advantage of local expertise	☐	☐	☐	☐	☐
Take advantage of emerging technology	☐	☐	☐	☐	☐
Enhance reputation of college	☐	☐	☐	☐	☐
Take advantage of faculty capabilities	☐	☐	☐	☐	☐
Expand capabilities of current faculty	☐	☐	☐	☐	☐
Fit well with other programs in the college	☐	☐	☐	☐	☐

Additional comments:

5) Technology forecasting* played what role in the selection, design, and initiation of the program:

☐ The program was based on an informal technology forecast supporting selection.

☐ The program was based on a general consensus of the college staff and faculty of the growing importance of the technologies involved in the program.

☐ The program was based primarily on the technologies represented by local industry.

☐ Neither formal nor informal technology forecasting played any important role in the selection, design, or initiation of the program.

☐ The program was based primarily on a formal technology forecast conducted for this purpose.

*Technology forecasting is a process using formal methodologies to project future needs for new technologies, to identify the advances in technology that will become available to meet those needs, and to analyze the implications of these market/technology interactions. There are more than 50 practical, proven methods and techniques available for making such forecasts.

6) How strong was the support for the new program by the following group?

	Strongly supported by all	Solid support of majority	Moderate support of many	Limited support from few	No support from any
Advisory Committee Members	☐	☐	☐	☐	☐
Students	☐	☐	☐	☐	☐
Faculty	☐	☐	☐	☐	☐
College Administration	☐	☐	☐	☐	☐
Local Industry	☐	☐	☐	☐	☐
Local Workforce Commission	☐	☐	☐	☐	☐

Additional comments:

7) How much effort was involved in preparing the curriculum for the program?

- ☐ Less than two person-months*
- ☐ Between two and five person-months
- ☐ Between five and ten person-months
- ☐ Between ten and twenty person-months
- ☐ More than twenty person-months

*A person-month is defined as one person working on the program development process for 20 days.

8) Who had primary responsibility for developing the program?

- ☐ A single faculty member
- ☐ A group of faculty members
- ☐ One or more members of the college administration
- ☐ A group of faculty and administration members
- ☐ Other

If you selected other, please specify:

9) The program was:

- ☐ Adopted essentially intact from a similar program offered by a different college
- ☐ Adapted from a similar program offered by a different college
- ☐ Developed together with a different college
- ☐ Developed together with local businesses
- ☐ Developed entirely by your college personnel
- ☐ Other

If you selected other, please specify:

10) How was the faculty for the program selected?

- ☐ Entirely from existing faculty
- ☐ Primarily from existing faculty with some new hires
- ☐ Primarily from the existing faculty with some outside experts
- ☐ Almost entirely from new hires
- ☐ Contracted to an outside agency
- ☐ Other

If you selected other, please specify:

11) How much time elapsed between origination of the idea for the program and its formal initiation?

- ☐ Less than three months
- ☐ Between three and six months
- ☐ Between six and twelve months
- ☐ Between one and two years
- ☐ Other

If you selected other, please specify:

12) How was the new program advertised? (List all activities)

- ☐ Special announcement in college catalog
- ☐ Special bulletin circulated around campus
- ☐ Announcement in college newspapers
- ☐ Announcement in college assemblies
- ☐ Notification sent to local industries
- ☐ Announcements on local radio or television
- ☐ Other

If you selected other, please specify:

13) In what year was the program initiated?

☐ (e.g., 2001)

14) In what year was the first class graduated?

(e.g., 2002)

15) How many people enrolled in the first offering of the program?

16) How many of these people completed the program?

17) How many of the original group of graduates were employed in the field of the program or a closely related field within two months of graduation?

18) Is the program still being offered?

Yes

No

19) What was the last year that it was offered?

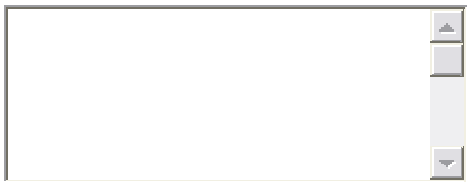
(e.g., 2001)

20) What is the general level of satisfaction with the program among the following groups?

	Extremely well pleased	Well pleased	Satisfied	Satisfied with reservations	Unsatisfied
Students					
Faculty					
College Administration					
Local Government					
Board of Advisors					

Additional comments:

21) What lessons did you learn from the establishment of this program?



The following questions are designed to determine the relative importance of various criteria that influence colleges in selecting new programs for development. Your input will provide a measure of what is important to your organization and will allow future analysis efforts to best meet your organization's needs. When answering the following questions, consider all new program development initiatives in general.

22) How important are these criteria when selecting a new program development initiative?

	Extremely Important	Very Important	Important	Not Very Important	Not Important At All
Potential Student Salary					
Probability of Prompt Employment					
Related Employment Opportunities					
Foundation for Further Education					
Ease of Offering					
Compatibility with Current Programs					
Prestige					
Revenue Potential					
Supports Existing Industry					
Supports New Industries					
Supports Local Industry					
Supports Regional Industry					

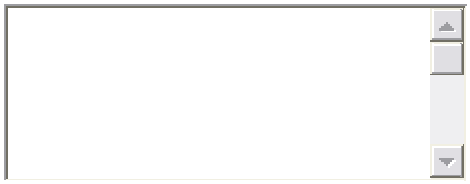
Benefit to Texas	☐	☐	☐	☐	☐
Attracting New Industries	☐	☐	☐	☐	☐
Retraining Opportunities	☐	☐	☐	☐	☐
Potential Size of Industry	☐	☐	☐	☐	☐
Time to Reach Attractive Size	☐	☐	☐	☐	☐
Potential for Follow-On Industries	☐	☐	☐	☐	☐
Lifetime of Industry	☐	☐	☐	☐	☐

23) Besides the criteria listed above, what additional criteria does your organization consider when selecting a new program for development?

24) What methodologies does your institution employ in the process of selecting a new program for development?

25) List all the known sources of information that your institution relies upon in the selection of new programs to develop.

26) What types of validation documentation does your institution typically require prior to investing in the development of new programs?



27) Other Comments:

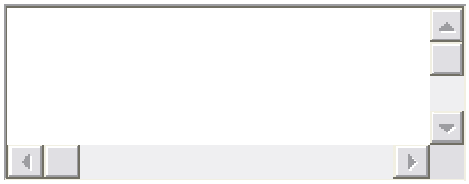
28) Person completing this survey*

Name:

Title

Organization

Mailing Address:



E-Mail Address:

Telephone #:

**This contact information is intended for validation and future survey work and will not be distributed external to this research initiative.*

Thank you again for your participation. The results of this survey will be published as soon as analysis is complete.

C

Programs Initiated

Title of Program	Brief Description of Program
Help Desk Support Level 1 Certificate	The Help Desk Support Level 1 Certificate prepares students to support desktop computer users. Students will learn basic computer application skills used within business and industry.
Business Office Support Specialist	Microsoft certified administrative assistant, with either/and a certificate of proficiency (Word and Excel), Expert Certificate in Word or Excel or PowerPoint or Access, and/or a Master Certificate in MS Office (all four).
IT Project Management	A comprehensive program to prepare students for multilevel international certification and employment in project management.
Project Management	Advanced project management training from a business management perspective and in preparation for the Project+ or CAPM certification.
Computer Graphics	The program allows students to gain skills in using industry standard equipment and software and stresses the role of motion graphics in designing and producing professional graphics for the web, animation, and video games.
E-Commerce	Addresses the changes in business use of the Internet and the new business processes available because of Internet technologies.
Multimedia Web Design	This AAS degree is designed to enable students to participate as creative resourceful members of a web development team.
Network Security Technology	Train technicians to work with network administrators in order to secure communication services.
Cisco I	Skill development in the design and installation of local area networks to ensure optimal throughput.
PC Desktop Support	Specialization in the Computer Information Systems AAS degree. Prepares students for jobs as an office manager, administrative assistant, help desk support, or trainer.

Web Mastery Specialization	Associate in Applied Science in Information Systems. Teaches the skills needed to create effective and profitable websites.
Software Engineering & E-Commerce	The E-commerce & Software Engineering Program offers a focused, hands-on approach to instruction in a breadth of disciplines necessary to power enterprise information systems.
Cisco Networking Academy	No response.
Business Computer Information System	The Business Computer Information System program is a 15-week continuing education program taught at the Texas Department of Corrections.
Geographical Information Systems	The GIS program is designed to prepare students for careers in industry or government as a cartographer or technical staff assistant in engineering; planning, or marketing departments.
CISCO Academy	This program prepares successful completers the opportunity to become certified as CISCO Network Administrators.
Microsoft Systems Engineer	The MCSE training will prepare students to implement and support websites as well as implement Internet information servers.
Geographical Information Systems	GIS technology; including mapping, geography, and computers.
Computer Maintenance Technology	Two-year degree in computer maintenance and networking.
Geographic Information System	The GIS AAS Degree has 69 sch. This is a cooperative program between Geography and Engineering Technology. GIS courses are being offered with the geography prefix to facilitate transfer.
Information Technology Technician	Graduates will be able to install, configure, and troubleshoot local and wide area networks; respond to computer users' inquiries, complaints, and requests for assistance; repair and maintain computers, components, and peripheral equipment; and coordinate with management, network database administrators, and computer users within a company to determine the proper software and reporting requirements to meet the information needs of the organization.
Certified Cisco Systems Networking	The college offers the CCNA certification (13 semester hours) through Cisco Systems and has a one-year certificate with 13 additional semester hours.
Certified Cisco Networking Systems	Students utilize the Cisco Systems training program for college credit and can earn CNA status.
Information Technology Networking	As one of five possible IT majors, students learn Cicsco, Novell, and Microsoft networking tools as well as UNIX and basic computer maintenance.

Micromanufacturing Technology	Micromanufacturing Technology prepares students to understand the process of manufacturing semiconductors and their uses in our daily lives.
AAS in Computer Information Systems	This was not a new program. It is an existing program that adopted variations of a degree, offering courses in different specializations.
Computer Networking	How to network computers, including software and hardware.
Network Specialist	Course of study devoted to preparing students for passage of Microsoft Certified Systems Engineer.
Management Information Systems (MIS)	To provide knowledge and credentials necessary to manage and maintain computer networks.
Dental Assisting	A competency-based program teaching the skills, knowledge, and perspectives needed in the dental assisting field including oral and written communications specific to the workplace.
Emergency Medical Services	The program is designed to prepare students for entry-level employment in emergency medical services. This program includes an EMS—Emergency Medical Technician Basic Certificate and an EMS—Paramedicine AAS Degree.
Dental Hygiene	AAS. Prepare students for careers as dental hygienists.
Diagnostic Medical Imaging	Program leads to Associate of Applied Science degree. Graduates will be eligible to sit for the certification exam given by the American Registry of Radiologic Technologists.
Pharmacy Technology	Prepare graduates to work as a pharmacy team member.
Diagnostic Cardiac Sonography	Prepares individuals with limited medical background for work as a diagnostic cardiac sonographer (echocardiographer).
Respiratory Therapy	Respiratory Care Associate Degree Program.
OTA (Occupational Therapy Assisting)	Occupational therapy assisting.
Pharmacy Technology	The Pharmacy Technology Certificate program is a two-semester certificate designed to prepare graduates for entry-level employment as pharmacy technicians in both community (retail) and institutional pharmacies.
Phlebotomy	A one semester, 15-credit, TASP exempt level one certificate program, combining theory, clinical, computer skills, and professional development.
Pharmacy Technology	The objective of the program is to prepare students to become pharmacy technicians. Pharmacy technicians fill orders for unit doses and prepackaged pharmaceuticals and provide other related

	duties under the supervision of a pharmacy manager or staff pharmacist and mix drugs with parenteral fluids.
Pharmacy Technology	Pharmacy Technology is a certificate program designed to train pharmacy technicians to assist registered pharmacists. It is a one-year certificate program.
Vision Care Technology	The Vision Care Technology Program provides the student with skills to enter the field of vision care as an assistant or technician. Student will qualify to assist in the offices of optometrists and ophthalmologists, or in optical offices.
Radiation Therapy	Graduates would work in radiation treatment facilities, specializing in patient care.
Histologic Technology	One year certificate. First in Texas. Accreditation site visit this fall. Histo techs prepare tissue samples for analysis by a pathologist.
Emergency Medical Services	To prepare graduates as Emergency Medical Technicians at two certificate levels and at the AAS degree level. The AAS degree level articulates into a bachelor's degree through the Department of Allied Health at TTUHSC.
Emergency Medical Services Professions	AAS. This program would qualify students for licensure under the Texas Department of Health, Bureau of Emergency Management Rule 157.40. Licensed Paramedic is the highest level of practice for pre-hospital emergency care personnel. Students achieving licensure are eligible to work on Mobile Intensive Care Units and Advanced Life Support Ambulances in both the public and private sector. In addition, hospital emergency departments and critical care units now employ EMS professionals to augment shortages in nursing.
Biotechnology AAS and Level I Certificate	The program is designed to prepare the graduate for entry-level positions in biotechnology, biological research, and industrial laboratories.
Biotechnology	Instruct students in application of scientific principles and skills in support of biologists and biotechnologists in research, industrial, and government lab settings.
Biotechnology	Technician training in the field of biotechnology.
Biotechnology Program	The Biotechnology Program is designed to prepare skilled technicians to work at the entry level in research laboratories, service and quality assurance laboratories.
Biotechnology	Prepares students to successfully perform tasks required in the basic research and industrial laboratory areas

Construction and Forestry Equipment Technician (C&F Tech) Program	A two-year associate degree program, the C&F Tech program is a partnership between the college; a major manufacturer and its dealers. It is designed to prepare service technicians for heavy equipment.
Machinist/Machine Technology	Associate degree program with certificates to train industrial machinists and millwrights. Includes a specialty on computer numerical control machining.
Industrial Maintenance	This program is designed to train maintenance personnel for local industry.
Industrial Production Technology	Associate of Applied Science Degree that provides general knowledge of manufacturing industry. Allows the graduate to work in production, maintenance, and repair or quality control.
Machine Tool CNC Operator	Hands-on experience in the design and development of machine programs and the use of CNC machines in the production of designed parts.
Fuel Cell Technology	A program designed to prepare students for employment in the repair, maintenance, and installation of various types of fuel cells used in industry.
Airframe and Power Technology	Designed to provide instruction to enable the student to sit for the A&P exam to be certified as an A&P mechanic.
Process Technology	This program is designed to teach students the cutting-edge technical skills for a rewarding career as a process operator with area petrochemical plants. Students will learn about process equipment, TQM, troubleshooting, and more.
Process Technology	The process technology program offers courses related to process operations that will prepare students to become process technicians in the refining and petrochemical industry.
Petrochemical Process Technology	Associate in Applied Science. The Petrochemical Process Technology Program will develop and supply a technically prepared workforce to be employed by the refining and petrochemical industries.
Automotive Collision Repair Technology	An AAS with two certificates designed to prepare graduates as entry level auto collision repair techs. The certificates are subsets of the AAS and specialize in either refinishing or collision repair.
Aviation Maintenance Technology	AAS degrees and certificates in Power Plant and Airframe Technology to meet the needs for maintenance technicians at the Army Depot, off-shore industry, and aviation-related industry within the area.

Environmental Technology	A program of study designed to prepare the student to enter the workforce as an environmental field technician, environmental lab assistant, safety and health technician, etc.
Heat, Ventilation, and AC	The Aviation Maintenance Program consists of two certificate programs and associate degree. Students who complete the program are eligible to apply for jobs relating to repair and maintenance of heat, ventilation, or air conditioning systems.
Pilot Training	Train students to fly commercial aircraft for regional airlines.
Auto Body Repair	This program will provide students with detailed knowledge of both body-over-frame and unitized construction automobiles.
Criminal Justice Program	An Associate of Science in Criminal Justice Degree. We also offer a 45- and 30-hour certificate.
Criminal Justice	This program is designed for those with criminal justice backgrounds, as well as recent high school graduates interested in preparing for employment in the fields of law enforcement, corrections, probation and parole, or private security.
Basic Correctional Officer Training	Trains correctional officers for employment with the Texas Department of Criminal Justice.
Veterinary Technician	Two-year associate degree. The program prepares the student for entry-level employment as a veterinary technician and to be registered by the Texas Veterinary Medical Association.
Turf Grass Management	Golf course and turf grass management program designed to prepare students for employment in managing the grounds operations of a golf course.
Alternative Teacher Certification	An online program designed to provide persons with bachelor's degrees in specific disciplines the opportunity to earn a teaching certificate through a non-traditional course of study.

D

Participant Responses

1. Response of Brent Kesterson, Richland College

Needs Assessment

Purpose

The purpose of conducting a needs assessment is to determine the *magnitude* of the training need. In this first phase of the P-BID Model, we survey the needs of the community and document how many people are potential students for this training. This phase of the P-BID Model will be vastly different for corporate trainers. Since it will differ so significantly between different types of corporate structures, we will only address needs assessment for colleges.

Importance

Both the quality and quantity of the needs assessment research are critical to the success of any new instructional program. When organizations take shortcuts and hurry through the research, they are likely to end up with a program that will not succeed and will be an unwise investment of time and other resources. On the other hand, no organization can afford to have "analysis paralysis" and take too long in front-end analysis. Our goal is to achieve a rapid response to local training needs without taking shortcuts that will sacrifice the quality of data gathered. That is, of course, a very delicate balance.

Steps of the Needs Assessment Process

Determine Collaboration Needs

This may be unique to the Dallas County Community College District only; however, any organization may benefit from considering collaboration. The Dallas County Community College District requires us to notify sister colleges whenever we want to explore a new program. If we decide to explore the feasibility of a new program, we announce it on the "Explore" e-mail group, and sister colleges have 30 days to indicate that they want to participate.

Collect Subject Matter Expert Information

One of the most valuable sources for assessing training needs is subject matter experts (SMEs). We contact local businesses to identify SMEs. They may be high-level supervisors, first-line supervisors, or human resource managers. We frequently spend a lot of time on the phone interviewing such people to determine what job title and brief job description to use. We also conduct a brief survey of how many people their company currently hires or expects to hire with these skills in the next three years.

Another type of SME that we involve early in the process is faculty. When we are exploring an emerging or new occupation, we often do not have faculty to consult. This can be a bit of a challenge. Most colleges cannot afford to hire full-time faculty in the early stages of program development.

Since the availability of SMEs from industry is frequently limited by their high-demand jobs, project development may suffer long delays. We have found it necessary at times to hire consultants who were SMEs with industry experience and contacts. We prefer to use volunteers in new program development, but when we encounter continual delays because the SMEs have higher priorities at work, we have contracted with consultants.

When you explore the feasibility of a new academic transfer program, you may want to consult with faculty from the colleges to which your graduates transfer. You may also want to consider consulting with area business representatives that will hire individuals with four-year degrees in that academic discipline.

Gather Reference Information

This used to be a much larger section of government and other publications. Most of the printed publications are now available on the Internet. See next paragraph for more information.

- The *Occupational Outlook Handbook* is another Department of Labor publication that is quite useful (also see Internet address below).
- Job descriptions (from local companies).
- Existing training materials (from corporate trainers or other schools).
- Professional association information.
- Classified ads in the local newspaper. Sometimes we will do a thorough compilation of classified ads related to a specific job for a period of several months. We will summarize the data and make recommendations for further action.

- Vocational-Technical Education Consortium of States (V-TECS), Curriculum Publishing Clearinghouse (1-800-322-3905).
- National Center for Research in Vocational Education (1-800-637-7652).

The Internet is a tool that we rely on heavily now for occupational information. The only limitation to data obtainable on the Internet is your imagination. You can find so much more than we ever were able to from reference materials in the past. The only problem is that site addresses change fairly rapidly, so addresses are outdated quickly. Just a few of the sites you might want to use are:

- Career Development Resources, http://www.cdr.state.tx.us.
- Cyber Café's Index to Direct Job Information, http://bashful.cybercafe.cfw.com.
- The Department of Labor, http://www.dol.gov.
- The Occupational Network (O*NET), http://online.onetcenter.org.
- The National Skill Standards Board, http://www.nsb.org.
- Occupational Safety and Health Administration, Standard Industrial Classification Manual, http://www.osha.gov/cgi-bin/sic/sicser5.
- American Labor Market Information System, http://www.doleta.gov/almis.
- Career Magazine, http://www.careermag.com.
- Develop A CurriculUM (DACUM), http://www.dacum.com.
- Information Technology Association of America, http://www.itaa.org.
- Electronic Association of America, http://eta-sda.com.

Determine Proposed Job Title/Description

One of the first things you need to do is determine a job title and description on which the needs assessment will be based. You may need to conduct some preliminary fact-finding interviews with SMEs before you draft a job title or job description, if research data is scarce. These interviews may be done face-to-face or by telephone. Preliminary fact-finding interviews are especially necessary when assessing emerging occupations. Before you try to "nail down" the skills an occupation requires, it is normally important to get agreement from industry representatives on what job titles are used and to come to agreement on at least a one paragraph job description.

If you have difficulty formulating a job title and description, you may want to consider conducting a *nominal group* (NG) focus group before you begin an in-depth skills analysis. The NGT process was developed by Andre Delbecq and Andrew Van de Ven in 1968 and has become a widely-employed technique for

problem solving and research. We have used a rather loosely structured, open-ended NG approach at times and found it very helpful in getting started. The Develop A CurriculUM process and NG methods have many similarities. Both can provide a great start for skills analysis. An excellent source of information about this process is a book entitled *Group Techniques for Program Planning: A Guide to Nominal Group and Delphi Processes*, by Delbecq, Van de Ven, and Gustafson (Scott Foresman & Company, 1975).

Design Survey Form and Cover Letter

Construct a cover letter to send with your needs assessment survey form. The letter should identify the job title (or several commonly used titles) and clearly describe the job for which graduates will be trained. Companies are more receptive to letters that use their specific names and addresses than generic form letters. We use the mail merge function of our word processor for this purpose.

The survey form should contain questions that will clearly document the immediate need and the need for the next three to five years. Companies may be reluctant to divulge their long range needs, but it is important to document that the need is not just short term. Another area to survey is what incentive will the businesses offer to people who have acquired this training? In other words, if companies say they like the idea of employees and job applicants taking this training but they don't require the training to be hired, nor will they reward employees for completing the training, they don't value the training highly enough. If the students have no incentive for taking the training, most won't. In some occupations, job applicants are needed so badly that companies will hire people without the training for the very same salary as those who complete training. Obviously, there would be insufficient reason for people to spend the time and money to obtain the training in a situation like this. Consequently, a lot of money may be wasted in setting up a program in which classes won't "make." This would be a costly mistake that can be avoided.

Conduct Needs Assessment Survey

When exploring the feasibility and desirability of developing a new college program, you will need to conduct a survey to determine that there is a large enough potential student population to warrant the expense. If you can clearly document that there is a large enough potential student population without conducting a mail-out survey, that is good. In some cases, we have had one or two companies document that they need hundreds of people trained in a particular technology program. The potential danger of relying on one or two companies is obvious, but sometimes necessary. Ordinarily, it is best to build programs that will draw students from the service area at-large rather than a small segment of it.

Determining to whom and where you will mail surveys can be a difficult decision at times. This is especially true today with more "occupational" skills cutting across all types of occupations. Some of the best sources for mailing lists are professional associations. If there is a professional association related to the occupational program you are exploring, you may be able to obtain a mailing list free of charge. Other times, you may be required to pay a fee, but it is generally worth it because you will have a much more accurately targeted audience. The Chamber of Commerce is another good source of mailing lists. You may also buy specialized mailing lists from various companies. They are frequently quite expensive.

Another important consideration is the number of mail out surveys that should be sent. If there is only a limited number of businesses in your area that are likely to need employees with the skills this new program would provide, this is not a problem; however, many times, we have thousands of companies to which we could mail surveys. In this case, we will usually limit the number to about 300 companies that are selected using a random numbering system. Occasionally, we add criteria to which companies will be considered for selection from a list. For example, you may want to limit the companies considered for selection to those with a minimum of 500 employees and/or a minimum gross national income. This kind of data is available from various sources.

We have found that companies respond better to surveys that are faxed to them. We're not sure why this is true. One reason may be that it is somewhat easier to check off some blocks and fax it back than to mail it. We faxed a survey several years ago with an incentive that the first 20 respondents would receive a $100 training voucher for continuing education. Within 24 hours, we had return rate of over 20%. We believe that survey was extraordinarily successful for several reasons. First, we obtained fax numbers and names from a professional association. Second, there was a critical shortage of people trained in this occupation in our area. Last, but not least, various respondents indicated they were hoping to obtain a training voucher.

Analyze Survey Data

We recommend tabulating the survey data in a word processor that has tabling capability. Analyze the data to determine the size of the potential student population, and make recommendations to proceed or not with the program development.

Form Advisory Committee

If you decide that it is feasible to develop a program, and you have not yet formed an advisory committee, you may want to do so before you start the next phase. We usually form a temporary task force of subject matter experts early in the needs

assessment phase. Then, if we decide to proceed with developing the program, we will establish an Advisory Committee made up of the best members of the task force and others. Advisory Committees should be composed of people who represent the needs being served by the proposed training. If the proposed new program is for occupational training, the advisory committee should have representatives from business in your service area that hire such people. If the proposed new program is an academic transfer program, you might want an advisory committee that includes faculty representing the colleges to which students will be likely to transfer. Working closely from the beginning with appropriate advisors who are enthusiastic about developing the program will result in invaluable information and assistance.

2. Comments of Dr. Jerry E. Hutyra, TSTC Waco

In response to your e-mail below regarding technology forecasting methods for future program development, I have prepared the following strategies and procedures for your information:

1) The Network Security Technology (NST) program began with suggestions and ideas from presently-active local advisory committees for new program needs. An executive order from TSTC's Board of Regents was needed and granted in order to gain funding and approval to pursue the design and development of this new workforce occupation.

2) An industry survey was designed and developed to validate suggestions brought about by the local advisory committees. At this point in time, TSTC Waco was attempting to identify potential "stakeholders" who would support the concept.

3) Then, an internal process began with close cooperation between this office (Coordinator of Curriculum) and essential instructional personnel; "brainstorming activities" followed by an industrial needs assessment were conducted.

4) A DACUM was then arranged and conducted to further identify basic program competencies.

5) Afterward, a coordinated effort was conducted to form an advisory committee composed of industrial experts to assist with the program development.

6) Then, assigned department personnel and the Coordinator of Curriculum began the initial phase of designing and developing a systematic arrangement

of courses (curriculum) according to Texas Higher Education Coordinating Board (THECB) guidelines and regulations. Additionally, future funding arrangements, an anticipated number of graduates, and an occupational history with background information was constructed and devised.

7) Completed documentation on approved THECB forms was submitted to a TSTC Waco internal audit committee specializing in curriculum design and development for their inspection and approval. This group is known as the Classification of Instructional Programs (CIP) Committee.

8) Finally, the entire new workforce development package is submitted to the THECB for their approval to begin its initial phase of instruction.

3. Response from Dr. Duane Jacobs, Frank Phillips College

Informal Technology Forecasting Methods in the Selection, Design, and Initiation of the Management Information Systems Program

The MIS Program at Frank Phillips College is comprised of two specialties: Cisco and Microsoft Networking. IT/MIS/Computer Science faculty of FPC identified the need for these two specialties based upon:

1) *Student interest in these areas at the high school level*. Local ISDs had demonstrated student interest, Tech Prep was moving toward including these areas in their statewide articulation plan, and college students were beginning to inquire about college level courses.

2) *Available equipment and software*. Cisco and Microsoft have demonstrated to be long-standing front runners in their respective areas. Equipment and software is cost effective, readily available, and easily adaptable to the classroom. Both corporations provide licensure exams which can be incorporated as a part of the curriculum.

3) *Available training and faculty development*. Training and certification is available at the Region XVI Education Center in nearby Amarillo, at several provider sites (e.g., Dallas County Community College), or at corporate (Cisco or Microsoft) "bootcamps."

4) *Employment opportunities* (e.g., check the Pantex-BMXT website for employment opportunities).

The determining factor of implementing these specialties in the MIS Program was generated through the MIS Advisory Committee. Members of local businesses and industries, educators, and engineers enthusiastically, emphatically, and without solicitation suggested these directions.

The result of these factors was the implementation of the Cisco and the Microsoft Windows 2000 Networking programs during the summer of 2001. Both programs include a Certification of Completion and can lead toward an AAS in Management Information Systems.

I hope your study yields valuable results. If you would care to share any of your discoveries we would be interested in receiving them. Thank you.

E

Current Criteria for Selecting New Programs

Development Costs/Resources Available (24)

- Start up costs (11).
- Both human and fiscal resources to support program development and sustainability.
- Budget implications are also considered with new program development.
- College budget and availability of funds to start new program is extremely important.
- Cost effectiveness.
- Does the college have the resources to provide quality facilities and equipment as needed to provide state-of-the-art training.
- Development costs.
- Estimated cost to maintain technical skills for faculty.
- Finances.
- Financial ability to fund the program.
- Funding for development and equipment acquisition.
- Potential for grant or industry startup money availability.
- Resources available to offer and maintain.
- Will the program be fiscally sound within five years of its inception? Is the program within the mission and strategic plan of the college? Will the college be able to obtain the human and physical resources to support the program?

Need for Program (12)

- Attractiveness to students; relevancy for today as well as future.
- Demand for training by students and by workforce commission, industry credentials.
- Employment opportunity forecast.
- Fill the defined need.
- Four-year university needs, program availability at other colleges.
- Industry demand analysis.
- Need of students and industry for skills learned.
- None. Local need is the most important.
- Number of existing programs in the geographic area.

- Regional, state, and national need.
- Statewide need in this particular case. Local and service area need for any.
- Turnover rates, number of grads already being produced in similar programs nearby, speed/frequency of changing technologies/skills.

Faculty Availability & Credentials (11)

- Availability of faculty.
- Available faculty/salaries.
- Available faculty at a reasonable salary.
- Available qualified faculty.
- Availability and credentials of faculty.
- Expertise of faculty.
- Faculty credentials.
- Faculty certifications required to offer certain courses. (Example: Microsoft, Novell, Cisco.)
- Faculty potential.
- Ours is a very faculty-driven process, so all consideration is primarily based on their evaluation of the above considerations.
- Source of full-time and adjunct faculty certified in technology areas.

Industry Support (9)

- Industry support (2).
- Job market for completers (2).
- Availability of community partnerships and liaisons, especially opportunities for external learning.
- Business buy-in.
- Has the support of the industry, Work source board/TRC.
- Local support for instructional, external experience.
- Support from future employers to provide equipment and supplies for the program.

Available Equipment & Facilities (4)

- Facilities (2)
- Equipment required.
- Existing facilities including laboratories and computer technology in place; space.

Support from other Institutions (4)

- External accreditation potential.
- Support for program by transfer university.

- Potential articulation with universities; possible articulation with local area high schools.
- Transfer to four-year institutions.

Other Answers (15)

- The above criteria cover considerations of new programs (4).
- All pharmacy technicians in Texas are mandated to get certification.
- How will it benefit the student.
- I didn't understand the last three criteria.
- I have only been with the college for approximately one year. I am not aware of any formal criteria for developing a new program or award. I believe the areas addressed in this survey are important in determining whether to start a new program or award.
- If program offered by sister college in District.
- Industry shift schedules.
- It is important that the new program be a strong addition to the overall development of the college.
- Lag time between biennial base years.
- Number of potential students who are likely to attend because there are incentives such as a better job, higher wages, promotion, job security, etc.
- Safety of students/faculty.
- Strong support of advisory committee.
- Student potential.
- The statements above cover the criteria Howard College uses.
- What are the six colleges in the area offering?

F

Methodologies Used in Selecting New Programs

Advisory Committees (24)

- Advisory board input (14).
- Advisory committee recommendation based on needs assessment, job opportunities, and industry feedback.
- Advisory committee formation and research.
- Advisory committee input and support.
- PCAL, advisory committee.
- Review of advisory board recommendations and regional needs.
- Skills Net Advisory Committees.
- The faculty/department chair convenes an advisory committee to explore the program. Labor market information is collected. Notification provided to ACCD Workforce Council. Program is approved by College Curriculum Review Committee, College Academic Council, and ACCD Board of Trustees.
- The program originates by perceived industry and business needs in the service area. The perceived need is investigated by a joint committee of business representatives and college staff. If the new program need is justified, an advisory committee is established. The college administration and staff work with the advisory committee to establish the program competencies and curriculum for the new program.
- We strongly depend on business, industry, government, education, and healthcare advisory committees to recommend and assist us in the determination as to what they see as essential near future needs, skills, and knowledge required of our graduates.
- We used an advisory committee and listened carefully to the needs and suggestions of the college and community at large.

Surveys/Data Analysis (21)

- Surveys (3).
- Local industry surveys (2).
- Community opinion, and information surveys of business needs.
- DACUM, local industry needs surveys, existing forecasting surveys done by industry, local workforce and district office task analysis.

- Environmental scanning, government data and reports.
- Extensive research—employment trends, technology trends, local business/industry relocations, etc.; Brookhaven College New Program Development Process (written document); DCCCD EXPLORE Process.
- Feasibility studies. Visioning sessions involving the Board, faculty, staff, and the community. Discussions by faculty and staff. Review of employment forecasts. Requests from students (informal and formal).
- Survey of other colleges; internal/institutional survey; survey of faculty to determine support.
- Informal surveying of businesses.
- Local survey of industry to determine employment need.
- Preliminary surveys to determine jobs and students. Salary earning potential surveys. Lifelong learning opportunities. The office of Institutional Research. Department of Labor/Workforce Commission Materials. Employer surveys. SIC materials. Student surveys.
- Regional surveys; business/industry focus groups.
- Research data.
- Research of similar programs. Surveys of local industry.
- Survey local and regional businesses, economic developments, etc.
- Surveys and conversations with industry representatives.
- Surveys, data analysis.
- Surveys of area advisory input. Workforce Commission data.
- Surveys mailed out to School Industrial Cooperative Committee (SICC) membership indicating new occupational areas of critical importance.

Market Analysis (21)

- Analysis of demand occupation data provided by area workforce development.
- Anticipate future job market demands as technology advances.
- Area workforce data.
- Demand.
- Employment trends as reported by the Texas Department of Comm. Tracer program.
- Endorsement of local workforce board.
- Job placement.
- Forecasts for future job openings.
- LMI data and forecasting.
- Labor market data (national, regional, local), industry predictions and publications.
- Labor market analysis, listing of emerging and critical occupations.
- Labor market studies.
- Labor market information is collected.
- Local economic development conferences are also important.

- Market surveys.
- Projections from Economic Development Council on measured demand for graduates.
- Review of employment demands and opportunities in the region.
- Review local labor market needs.
- Technology forecasting.
- TWC Labor Market Data.
- We use market analysis for job trends, local and regional industry interest in the program, student base and interest, and cost analysis to determine whether we can afford to begin the program.

Analysis of Need (18)

- Assessment of local need (2).
- Needs assessments (2).
- Analysis of need, student interest.
- Conduct a needs analysis survey among students, industry, and local governments.
- Informal needs assessment (interviews, phone calls, e-mails), formal survey of industry (15 questions) mailed, faxed, or e-mailed.
- Local need.
- Local/regional needs analysis.
- Most programs are planned in advance and included as new initiatives in the three-year comprehensive master plan. A local needs analysis is conducted to determine the overall need for graduates and the program in general. Other local, state, and national data are reviewed. Facility, faculty, and other budget implications are considered. Industry support is critical in selecting a new program.
- Needs analysis, curriculum development, local industry support, budget provided, faculty and staff provided, advertisement; institutional support.
- Needs assessment survey and labor demand data.
- Needs assessment of local employers.
- Needs analysis of region.
- Needs assessment, availability of curriculum, equipment, and faculty.
- Needs of the community, needs of students, needs of business and industry, and benefit to the college as a whole.
- The DCCCD Explorer Process—This process investigates and determines if there is a need for a proposed program.
- The Director of Program Development collects information on the content need, industries served, previous related successes, and presents it to the Cabinet.

Industry Support (15)

- Industry support (5).
- Consulting with local industries and advisors.
- Current trends in industry and the corporate sectors.
- Industry/business buy-in.
- Industry interest.
- Industry support is critical in selecting a new program.
- Informal contacts with key personnel within the industry.
- Input from business and industry.
- Notification by local workforce development board of a need for training, or interest by potential industry and business as well as the economic development arm of the city and region.
- Recommendations from area employers.
- Requests by employers and economic developers backed by LMI and institutional effectiveness data.

Program Costs (7)

- Cost (2).
- Develop and evaluate proposed implementation and sustainability costs. Project program income over five years.
- Projected start-up costs.
- Review of existing resources-faculty and facilities.
- Review of availability of faculty. Review of starting salaries.
- Staffing.

Administration/Faculty Involvement (6)

- Administrative and faculty input to provide informative approval from Advisory Board. Academic Standards & Curriculum Committee, Administrative & Board of Regents approval, THECB approval, SACS compliance.
- In general, faculty and administration do research and develop proposals.
- Input from college faculty and administration.
- On each campus, ideas for new programs are accepted from industry, advisory groups, faculty, students, administrators, staff, and virtually anyone else. The Technical, Academic, and Continuing Education deans collect and organize program ideas and submit them to the campus presidents and vice presidents of instruction. Campus presidents and vice presidents of instruction meet with District officials to review all programs recommendations. Program recommendations are ultimately approved at the District level for development by the campuses.

- Review by relevant administrators. Review by existing faculty. Approval by Curriculum Committee. Approval by Chief Administrative Officers, primarily concerning financial feasibility.
- We have a curriculum committee composed of faculty and administrators that must approve all new and changed programs. Faculty takes proposals to this committee. This is the only place administrators are really in the process. The administrators that will oversee the program are not necessarily involved in the development of the new or changed programs.

Other Answers (8)

- Community requests, budget analysis, equipment and space analysis, student interest, and technology changes.
- Establish articulation agreements with area school districts (Tech Prep) and senior colleges.
- Establish priorities.
- No formal methodology. Use internal process.
- Pilot potential new programs through non-credit workforce classes to help assess feasibility of offering program.
- Potential student population.
- Success of other Community Colleges as reflected in the annual data profiles.
- The criteria listed above are sufficient.

G

Sources of Information

Data from Agencies (101)

- TWC (16).
- U.S. Department of Labor (8).
- Chamber of Commerce (7).
- Bureau of Labor Statistics (6).
- SOICC (6).
- BLS (3).
- Interlink (3).
- Local workforce development board (3).
- OES lists/codes (2).
- SCANs (2).
- THECB (2).
- Targeted occupations list (2).
- 1,001 Exemplary Practices in America's two-year Colleges.
- Alamo Workforce Development subscribes to an LMI system that does an extensive survey of employers each year. We find this very useful. We also do our own survey. Other than that, research is different for each new program.
- Alamo Workforce Development.
- America's Health Care Source.
- American Career Kit.
- American Labor Market Info System web.
- Capital Area Training Foundation.
- Career Mosaic.
- Career Net.
- Career Path.
- Career Perfect.
- Census data.
- Dallas Worksource North Texas Council of Governments lists.
- EDC Regional Workforce information.
- Health Career Web.
- High Tech Careers.
- High Tech Austin.
- Hot Jobs.
- Job Bank.
- LWBD.

- Latest statistics from Career Development Resources.
- Local quality workforce planning committee.
- O*Net (OSCAR).
- Occupational Outlook Handbook/projections.
- Office of Employment Projections.
- Other market data obtained from COG and local economic developments.
- Professional associations, regulatory agencies.
- Radiological Society of North America.
- Standards Board data (new).
- State data.
- Target industries.
- TechForce 2000.
- Tech Prep information.
- Texas Aerospace Commission FFA.
- Texas Career Development Resources.
- Texas Career Development Resources website.
- The Office of Institutional Research.
- The West Central Texas Workforce Development Board.
- Trade journals, newspapers, chronicles, coordinating board reports, lists of trends and emerging occupations, and/or word-of-mouth.
- WIA/DOL
- Websites in the industry or profession.

Surveys & Labor Market Information (51)

- Labor market information (8).
- Local needs surveys and results (4).
- Industry/market surveys (2).
- Student surveys (2).
- Area surveys (2).
- Business forecasts.
- Census and private data sources.
- City surveys related to new business/industry recruitment efforts.
- Demographic information.
- District forecasts.
- Employer surveys.
- Environmental scanning; economic forecasting from the Comptroller's office.
- External data (employment opportunities, emerging tech developments). Internal data (instructional and training requirements, available faculty).
- Evaluation and approval by the CCCCD CAB, which requires extensive documentation and needs assessment.
- Formal and informal questionnaires.
- Industry surveys, questionnaires.

- Labor market data, surveys of students and employers, and industry analysis.
- Local, area, state, and national statistics on program need and salaries.
- Local and regional economic development boards.
- Local industry data.
- Local industry survey data by college.
- Local needs survey, community Master Plan Industry survey.
- Local, regional, and state labor market analyses and forecasts.
- Local, regional, and national worksource statistical websites.
- Local, state, national, and international trends and issues; emerging and evolving technological advances.
- National and regional labor market data.
- National forecast on jobs.
- National/regional job forecasts; national/regional wage surveys.
- National, state, local agency reports.
- Needs analysis.
- Needs assessment surveys and polls.
- Obvious needs (local) trends.
- Regional, state, or national importance.
- Regional wage and data information.
- Specific industry data/projections.
- State demand list.
- Student responses to need assessment surveys.
- Technology trade information and databases.

Institutional Sources (35)

- WECM (3).
- Student requests (2).
- Accrediting body information (if available).
- Availability of qualified faculty and personnel, external experience site availability, potential pool of students.
- Both public and private educational institutions, students, literature.
- College Academic Council approval process.
- DACUMs.
- Discussion with four-year institutions.
- Faculty interest and similar programs at other institutions.
- Faculty requests.
- Faculty research.
- Faculty; vendor specifications/requirements; accrediting body/certification requirements; Workforce Education Course Manual (WECM); Guidelines for Instructional Programs in Workforce Education (GIPWE).
- Faculty expertise and availability.
- Faculty knowledge of trends and new areas.

- Graduate follow-up and WIA training provider data.
- Information and history of programs from other colleges and informal input.
- Input from college faculty and administration.
- Institutional data (enrollment, financial data).
- Interviews with other colleges.
- National Certification Programs.
- Other college catalogs.
- Other colleges, schools, and businesses.
- Other community colleges.
- Other programs within close proximity.
- Recommendations from faculty and administrators based on local needs.
- Rules and regulations, expertise available.
- Potential for continuing education beyond entry level.
- Programs at other community colleges.
- Students, other faculty members.
- Students, faculty, and staff.
- Student feedback/needs.
- Success of other community colleges as reflected in the annual data profiles.

Industry (32)

- Business, industry (11).
- Local business/industry requests (5).
- Industry input (2).
- Industry publications (2).
- Affiliated industry certifications.
- Business/industry consultants.
- Business/Industry personnel.
- Discussion with area businesses.
- Feedback and requests from industry groups/associations.
- Industry support.
- Industry statistics.
- Industry standard lists.
- Local council of governments, industry web-based information, calls on industry.
- Local and regional industry needs.
- Public and private corporate support.
- Trade publications.

Advisory Committee (24)

- Advisory committees (16).

- Advisory board concerns.
- Advisory board guidance.
- Advisory committee input is crucial.
- CCCCD Board of Trustees.
- Contacts with related advisory committees.
- Dallas/Fort Worth Hospital Board (or similar boards)
- Education, government, and healthcare advisory groups.
- Publications from governing bodies.

Employment Opportunities (22)

- CSR list of emerging and evolving occupations.
- Classified advertisements.
- Emerging and evolving occupations.
- Employer database.
- Employment and labor data from state agencies.
- Employment data.
- Employment opportunities.
- Employment projections from regional, state, and national sources.
- Employment trends.
- Employment trends as reported by the Texas Department of Commerce Tracer program.
- Formal surveys of local business/industry to determine employment opportunities.
- Government occupational outlook.
- Industry specific employment data.
- Job market for completers.
- Job outlook for the area for occupations.
- Newspaper advertisements for job listings.
- Newspaper classified ads.
- Occupational need.
- Regional data on employment needs and shortages.
- Regional and national demand occupation lists.
- State data on emerging and growing occupations.
- State employment needs related to local needs.

Financial Information (7)

- Cost of implementation (4).
- Cost analysis of startup and continuation costs.
- Cost projections, budget.
- Start-up cost based on industry standards.

Other Answers (13)

- Community input/involvement (3).
- Skill standards (2),=/
- Equipment requirements.
- Futurists' projections.
- Government.
- In addition to above, professional literature, grant-funded research and curricula, results from ATE centers, NSF projects, etc.
- In response to local needs as well as a means to determine the feasibility of offering an AAS in Information Technology Technician, Western Texas College (WTC) piloted a select number of individual WECM courses within in the proposed ITT curriculum during the fall 2000 and spring 2001 school year. Enrollment in the piloted classes was 97 class spaces and represented a varied population to include concurrently enrolled high school students, non-traditional students, and individuals from local business and industry. Based on the Texas 2000 Occupational Employment Statistics for a Computer Support Specialist, the annual wage was $41,230 and the median wage was $17.49 per hour. Network Systems and Data Communications Analyst, the annual wage was $51,990 and the median wage was $24.73 per hour. Computer Systems Analyst, the annual wage was $54,670 and the median wage was $25.55 per hour. Data Processing Equipment Repairers, the annual wage was $27,020 and the median wage was $12.24 per hour. (Source: Texas Workforce Commission/Labor Market Information Department)
- Journals.
- Web and direct communication.

H

Validation Requirements

Demonstration of Program Need (42)

- Labor market data/analysis (7).
- Needs analysis (3).
- Needs assessments (3).
- Local industry needs (2).
- Local needs surveys (2).
- A valid needs assessment must demonstrate both the need and that potential students would be interested.
- Advice from local business and industry.
- Any type of needs surveys.
- Area surveys.
- Business and industry surveys that document a need.
- Compelling data.
- Demand for graduates from the program, experts to direct the program.
- Demand/targeted jobs list from local workforce development board.
- Evaluation and approval by the CCCCD Curriculum Advisory Board (CAB), which requires extensive documentation and needs assessment.
- Formal needs assessment that documents the magnitude of the potential student enrollment- reviewed and approved by College Council (President, VPs, and Deans).
- Industry need.
- Letters of support from industry.
- Local business and industry surveys.
- Meeting notes from industry focus groups, industry survey results.
- Long-term need for graduates by local business/industry within specific technology field.
- Positive indicators from: (a) locally produced needs survey, (b) job placement information, (c) published salary range.
- Positive survey results from industry that support the need.
- Proforma P & L, survey results, focus groups.
- Surveys, studies, census data, DOL data, industry data.
- Texas workforce projections and demand.
- The program must be on the campus priority list. The needs assessments must indicate jobs, student availability, and value added salary.

- We require substantial documentation about the occupation and local needs, unless the occupation in on the state listing documenting a high need (statewide and regionally).
- We validate Wad's data with our local own survey. Chancellor's cabinet (Presidents) is now the first step in the approval process. This has helped a lot with district-wide consensus and support.
- Valid survey and documentation of need by TWC, local workforce board, or BLS of DoL.
- Validation of the need for the program and support from business and industry.

Agency/Committee Approval (24)

- Advisory board support and commitment (5).
- THECB approval (2).
- A five-year budget analysis.
- Accreditation—reaffirmation compliance.
- Advisory Committee consisting of industry experts and faculty.
- Advisory committee input.
- Advisory committee minutes.
- Approval of Advisory Council Proposal by Chair Presentation to Workforce Deans.
- Approval of the curriculum committee is really the only necessary step. We do little in the way of cost/benefit or needed training analysis prior to a decision.
- Chamber of Commerce committee.
- College board approval.
- Community advisory committee minutes, showing approval of the new program.
- Documentation of support from an advisory committee.
- Formal endorsement from advisory committee and response to letter of intent from Coordinating Board.
- Governing Board approval.
- Listing of industrial support personnel through the local Advisory Committee; Board of Regents approval; task analysis and DACUM.
- National Advisory Committee Approval.
- Regional Advisory Committee Approval.
- The Advisory committee must endorse the program. The Leadership Team must approve the program for development.

Cost Effectiveness/Financial Support (22)

- Financial resources (2).
- Revenue potential (2).
- A five-year budget projection plan.
- A projection of costs and enrollment.

- Ability of program to run in a fiscally responsible manner.
- Break even analysis.
- Budget requirements/constraints.
- Commitment of financial support from the college president, cost projection, assurance of adequate facilities and equipment, and needs assessments.
- Cost analyses with bids for equipment and cost estimates for faculty, etc.
- Cost assessment: ongoing costs and start-up costs. The college generally requires that program costs are feasible and do not create an undue burden on the budget.
- Cost effectiveness to ensure sound budgetary concerns.
- Cost/income analysis.
- Currently, we require financial support from business and industry before we will consider a new program.
- Detailed cost analysis.
- Facility and personnel resources.
- Financial support for the program.
- Income versus expenditure budget.
- Projected budget and revenue figures.
- Research all costs: equipment, faculty, facilities, memberships, accreditations, etc.
- We require a mini-business plan as part of our investigation. This is the initial part of our research and development phase, and this due diligence investigation, along with a pro forma sheet, forms the basis for making valid and good business decisions. This allows us to manage our budget, and maximize the benefits to our students in reaching or exceeding expected outcomes; employment, security, quality of life.

Employment Opportunities (10)

- Documented evidence of sufficient employment opportunities for graduates of program.
- Documentation of employment opportunities.
- Documentation of student interest.
- Documentation of future needs for qualified persons in this occupation (employment trends, state and national).
- Evidence of the employment longevity.
- Long-term industry need/employment.
- Positive indicators from: (a) locally produced needs survey, (b) job placement information, (c) published salary range.
- Regional employment forecasts.
- Salary potential for graduates in local industry.
- Student potential.

Industry Support (8)

- Documented support from industry in college's service area.
- Letters of support from local industry.
- Letters of support from industry management.
- Personal calls with related industries. We think that nothing is better than going to a group of industries that might need the training and discussing our plans on a one-to-one basis.
- Support of the respected industry.
- Supporting evidence from the community and/or local industry, i.e., equipment, job opportunities, or scholarships.
- Surveys and verbal commitments from industry for employment of students and help with technology needs.
- We also require a commitment from the local industry to advise in all development aspects of the program and to their need for qualified graduates of the program.

Evidence from Other Agencies (8)

- PCAL (2).
- Area workforce data survey data.
- BLS, TWC data.
- Local Workforce Board.
- Support for the program from Texas Workforce Commission.
- Workforce Commission data.
- Workforce Development Board.

Institutional Information (4)

- Assessment of the availability of qualified faculty.
- Determination of availability of adequate facilities.
- The use of DACUM and other similar curriculum contact collection process with integration of state and industry validated skills standards.
- Transferability of credits.

Other Answers (7)

- A five-year plan.
- An executive summary of those items listed in Questions 24 and 25. A curriculum proposal.
- Positive results of items identified in Question 25.
- Same as listed above.
- Space and equipment availability.
- The sources listed in the question above and the input from campus and local experts in the field.
- We use analytical methods, such as, PCAL, DACUM, job profiling/work keys, needs analysis, and/or industry skills standards.

Lessons Learned

Importance of Good Research/Marketing (13)

- Advertising is extremely important the first semester. After the first semester, students are the best source of advertisement. Equipment must be top-of-the-line, and budgets must be adequate to support the program. Continued communication with local business and industry is important.
- Emerging technology is expensive, yet leads to immediate benefits for graduates. Careful planning is necessary to offset expenses with market demand. Commitment is necessary to continue upgrading and modernizing so that curriculum does not become outdated.
- It is difficult to generate new program awareness. Personal contacts with industry are most effective, but limited by time available.
- It is also important to plan to phase the program in over time because the curriculum development is very complex and time-consuming and it is more effective and efficient to take this in "bite-size" chunks. Also, phasing in the program makes it much easier to modify the program as necessary as you learn from your mistakes.
- Need marketing. Need better evaluation methods.
- Plan ahead.
- Planning and implementation process needs to be refined.
- Take one step at a time.
- The key to success is planning.
- THECB has streamlined the new program process to make it faster and less paperwork.
- The need to market new programs and not to rely on "if you build it, they will come."
- Timing is important for program development. We are still a bit ahead of the curve for demand, so we are not seeing the large enrollments yet. The critical time for program implementation has to be based on a combination of demand and awareness of evolving needs in the industry. Marketing is critical for enrollment.
- We need a reliable process for technology forecasting prior to investing in new programs.

Importance of Industry/Advisory Committee (11)

- Addressing the needs of the local employers and producing graduates with those needed outcomes builds excellent support and satisfaction.
- Allowing industry leadership in developing and instituting programs tailored to their needs. Industry driven programs command significant support—through employment opportunities, innovative professional sharing opportunities, greatly enhanced industry vendor support, scholarships, internships, student recruiting, incumbent worker upgrading opportunities.
- Input from local business and industry is crucial.
- Input and participation from local industry is extremely important.
- It has fostered a great working relationship with local government and industry.
- Local employers should be a primary driving force in program creations.
- Partnerships with local healthcare entities and quality of advisory board members are critical.
- Put people on advisory committee with authority to make decisions in their businesses.
- That it is important to have industry buy-in and support.
- That it is extremely important to have industry contacts and support to provide some of the very expensive equipment and materials.
- The key to success is planning and obtaining advisory committee and industry support.

Faculty Issues (9)

- Development of acceptable curriculum requires total commitment of content expert. This task cannot be “added-on” to the workload of an existing faculty member.
- It was also very important to build into the schedule sufficient “release time” for faculty to develop the curriculum.
- New program development is dependent on the availability of funds and qualified faculty members are difficult to hire for specialized programs.
- That sometimes your second choice of instructor turns out to be better than your first.
- The necessity for a full-time college faculty member to fill the coordinator position, rather than an adjunct faculty.
- The program will be fully accredited this fall. Hiring a good lead faculty is the most important thing, and we did that. No major problems.
- This is the first time that we used a commercial training program online. It was favorable in most cases. However, training for the faculty was costly.
- We had great difficulty attracting qualified faculty because of the disparity between pay scales and education requirements of business and the

College. Dealer support is strong, but students must be recruited in the cities where the dealers are located which are all outside the College's service area. This causes problems with communication and recruitment. A very strong, dynamic faculty member with the proper education is difficult to find, and constant feedback is necessary with the dealers and Deere.

- You need to be very careful starting a program that your faculty is not yet certified to teach in. We still have not been able to offer the entire program because our faculty is not qualified to teach the higher classes. A part time faculty member is now working on upper-level certification to move the program along.

Funding/Equipment Needs (7)

- Consider cost of facility renovation; approach donor and foundations earlier in the process; consider salary of graduates during the process of developing the program.
- Extremely expensive program; FAA regulations complicated, detailed.
- Funding a new program is a big issue. College Boards are not always willing to take large amounts of start-up costs out of college reserves.
- New program development is dependent on the availability of funds, and qualified faculty is difficult to hire for specialized programs.
- One of the main problems we experienced was instructor qualifications. Since this was a new degree, individuals with the proper academic credentials did not possess the industry-related work experience required to provide students with the skills and knowledge expected from industry. Individuals with the industry-related work experience did not possess the academic credentials required by the college.
- There is a need for extensive lab space and storage. This aspect is often underestimated.
- This is an expensive program. It requires a variety of funding sources.

The Time Commitment & Work Involved (7)

- Collaboration with other colleges takes too much time.
- Curriculum/program development doesn't have to take two years when collaboration among all interested parties and commitment of resources results in intense responsiveness.
- Extra time required to submit the proposal to THECB and gain approval.
- It is quite challenging to identify industry expectations for skills in emerging occupational programs.
- Program development and approval take a great deal of time.

- Starting this program was a lot of work. I was responsible for 99% of the required paperwork. The folks at the THECB were a great help, especially Rob Franks, who was assigned my case.
- This process was very complicated. We had already gone through receiving approval for the certificate, but had to go through the whole process to create the Associates of Applied Science degree. Another issue was due to the WECM process. Since EMS courses were revised to WECM at the same time the Texas Department of Health was evaluating their requirements, it caused additional work. If the revision to WECM could have waited until the TDH had completed their evaluation, it would have helped.

The Importance of Communication (3)

- Collaborative programs have hurdles to overcome. Communication between partners is vital and difficult at times.
- Need to establish better rapport with the local high schools.
- Communications and expectations as to expected outcomes must be clearly stated to administration, faculty, and students in order to successfully obtain the outcomes determined at the beginning of the program.

Other "Tips" (8)

- Be careful when one large industry cites a need that is 100 times beyond the scope of the college, then decides not to build the plant.
- Consider EVERY constituency.
- External experts who have a following make the job of establishing the program easier.
- How to protect versus other competitive programs within/outside the college, i.e., vs. biology programs in academics.
- In some areas, challenges exist in helping businesses recognize what skills a graduate will have that will be useful to the company.
- No new lessons really learned—just reminded us all how difficult it is to start a new program properly.
- Students need more counseling about different IT careers. Most did not know what networking was involved. Much of the curriculum in this area is vendor driven.
- TWC data does not reflect CE needs like new certification regulations. The need for industry-specific Spanish skills is expanding in the health field.

J

Other Comments

- Changes in West Texas demographics and industry have caused us to look differently at development of new programs.
- I do not know of any new degree or certificate programs on this campus developed during the last five years. There have been many changes to existing programs and addition of some courses, but no new programs for which the questions asked can be answered.
- Information provided pertains to continuing education program development only.
- Most programs in this department were not created from scratch in the last five years, but many were revised significantly, mostly based on employer and advisory committee input.
- Question 17 should not apply in this survey because inmate students were not released from prison.
- Regarding enrollment and graduates: only three students completed the short certificate the first year of enrollment. Many of the six initial enrollees were still in progress working toward the longer certificate of an AAS degree.
- Technical programs are dependent upon the vitality of the industry in an area. The west Texas region is very hard-pressed to find any high tech industry. Therefore there are limited chances to begin high tech programs that will train people for existing industry.
- Thanks—anxious to see results. This will be very helpful to all of us in the community college sector.
- The area for which I provide leadership is strictly academic/transfer (liberal arts). However, during the past two years, there has been cross-over, and the academic transfer area has developed workforce education training programs. I will make sure that my counterpart who is Associate Vice President for Workforce Education also completes the survey. If you find that you prefer to have the survey information from workforce

programs only, I will understand you not including my responses in the survey. Also, I did not have information available to me today on the number of students who entered, graduated, and were employed two months after completing the program. I will gather that information and forward it tomorrow.

- The biggest drawback to the start-up of new workforce programs is the lack of start-up funding. It takes two or three years to receive funding from new contact hours generated in the first year of the program. Some programs, such as health and industrial technologies, require a considerable outlay in facilities and capital equipment.

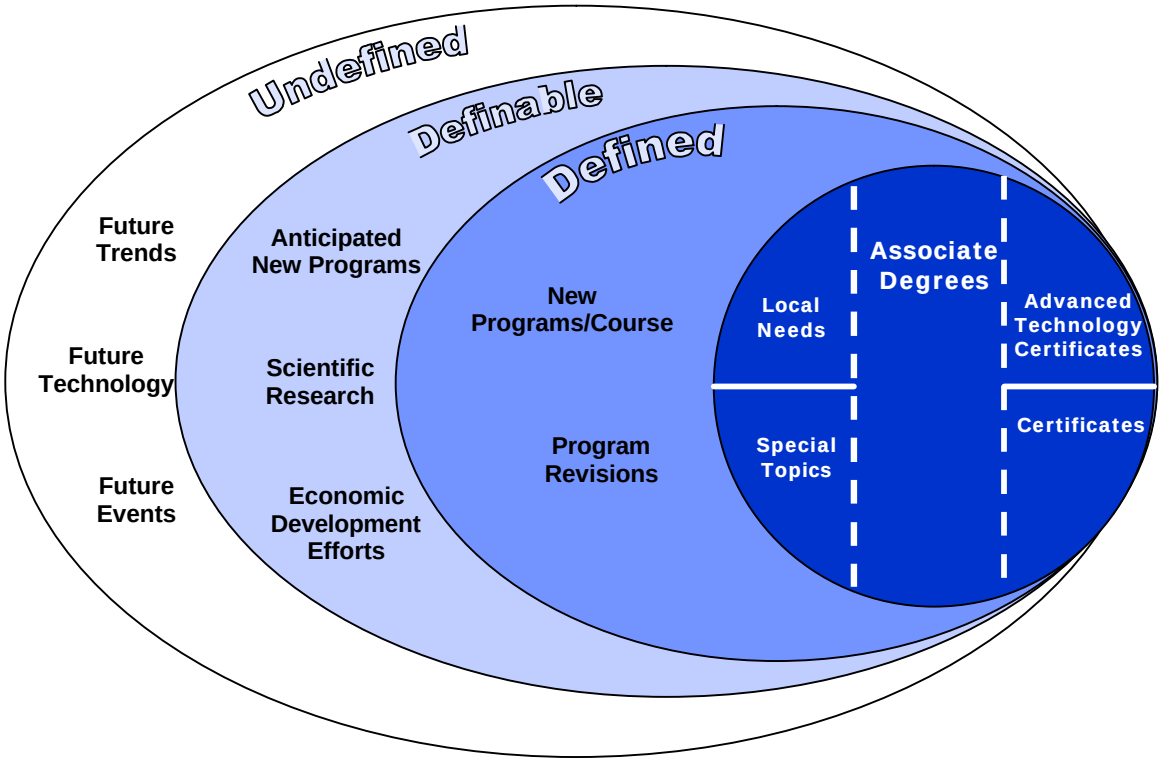
- The community and technical colleges in Texas are all doing this forecasting for themselves. It would be much more efficient and beneficial for Texas to do it more thoroughly and professionally for the entire state.

- The Vision Care program has grown from nine students enrolled in fall 2001 to 26 currently enrolled and 19 new students registered for fall 2002 classes. Support from industry vendors, as well as practitioners, has been better than expected with donations of needed equipment and supplies estimated to have saved the college more than $50,000.

- With this program we have a situation where inadequate preparation and analysis has brought us to the point of listing a program in our catalog that we have not and currently do not have the expertise to develop and offer all the courses in the program.

K

PET
Identifying Emerging-Technology Programs



L

Techniques & Methodologies Employed by Technology Futures, Inc.

Listed below are brief descriptions of some of the techniques and methodologies employed by Technology Futures, Inc. in conducting its technology/market forecasts.* The descriptions explain the rationale on which each technology is based, discuss the ways in which each technology is most commonly used, and indicate whether results are typically quantitative or qualitative in nature. The techniques are categorized by the different ways people view the future—as extrapolators, pattern analysts, goal analysts, counter punchers, or intuitors. Each of these approaches has its advantages and shortcomings. However, our experience has been that more valid forecasts result from the use of all five approaches rather than reliance on any one. Thus, in our technology/market forecasting projects we normally use at least one technique from each group.

Extrapolators

Definition—Extrapolators believe that the future will represent a logical extension of the past. Large-scale, inexorable forces will drive the future in a continuous, reasonably predictable manner, and one can, therefore, best forecast the future by identifying past trends and extrapolating them in a reasoned, logical manner.

Technology Trend Analysis is based on the observation that advances in technologies tend to follow an exponential improvement process. The technique uses early improvement data to establish the rate of progress and extrapolates that rate to project the level of progress at various times in the future. Results produced by this technique are typically highly quantitative. In practice, this technique is typically used to forecast developments such as the speed of operation, level of performance, cost reduction, improved quality, and operating efficiency.

Fisher-Pry Analysis is a mathematical technique used to project the rate of market adoption of technically superior new technologies and, when appropriate, to project the loss of market share by old technologies. The technique is based on the

* Source: J. H. Vanston, *Techniques & Methodologies Employed by Technology Futures, Inc*. White Paper published by Technology Futures, Inc., 2002.

fact that the adoption of such new technologies normally follows a pattern known to mathematicians as the "Logistic Curve." This adoption pattern is defined by two parameters. One of these parameters determines the time at which adoption begins, and the other determines the rate at which adoption will occur. These parameters can be determined from early adoption data, and the resulting pattern can be used to project the time at which market takeover will reach any given level. Results produced by this technique are highly quantitative. The technique is used to make such forecasts as how the installed base of telecommunications equipment will change over time, how rapidly a new chemical production process will be adopted, and the rate at which digital measuring devices will replace analog devices in petroleum refineries.

Gompertz Analysis is very similar in concept to Fisher-Pry Analysis. It is a better model for adoptions that are driven by the technical superiority of the new technology, but where customers do not suffer any significant penalty for not adopting the new technology at any given time. Like Fisher-Pry analysis, Gompertz analysis projects adoption by use of a two parameter mathematical model. In similar manner, early adoption is used to determine the parameters and the resulting adoption curve. Results are highly quantitative, and the technique is often used to project adoption of consumer products such as high-definition television, camcorders, and new automobile features.

Growth Limit Analysis utilizes a mathematical formulation known as the Pearl Curve to project the pattern in which maturing technologies will approach development limits. This can often be useful to organizations for analyzing maturing technologies, setting feasible research goals, and determining the utility of additional development spending. The technique can also be useful in determining if new technical approaches can be used to overcome apparent technical limits.

Learning Curve techniques are based on the fact that, as more and more items of a given type are produced, the price of production tends to decrease at a predictable rate. For example, each doubling of the total number of a particular item produced might result in a cost reduction of 15%. In some cases, key technical parameters may improve in a similar pattern. The learning curve phenomenon is reflected as a straight line on log-log graph paper, which makes projection relatively simple. Results from the use of this technique are highly quantitative. The technique can be used for setting price and technical performance targets for developing technologies, particularly in the middle stages of their development.

Pattern Analysts

Definition—Pattern analysts believe that the future will reflect a replication of past events. Powerful feedback mechanisms in our society, together with basic human drives, will cause future trends and events to occur in identifiable cycles and predictable patterns. Thus, one can best address the future by identifying and analyzing analogous situations from the past and relating them to probable futures.

Analogy Analysis is based on the observation that the patterns of technical development and market capture for new technologies are often similar to those for like technologies in the past. In applying this technique, forecasters identify appropriate analogies and analyze similarities and differences. Normally, it is desirable to identify more than one applicable example in order to minimize the probability of selecting false or inappropriate analogies. The results from application of this technique are typically semi-quantitative in nature, and they are often presented as a range of possibilities rather than a single projection.

Precursor Trend Analysis takes advantage of the fact that, often, the development of one technology lags the development of a related one by a constant period. For example, the first application of technical advances in passenger cars typically occurs approximately four years after their application in racecars. Similarly, the application of new technologies in commercial products tends to follow laboratory demonstration by a relatively constant period. One can, thus, project the status of the lag technology at some future date by observing the status of the lead technology today. This technique also allows the extension of lag technology forecasts by building on forecasts of lead technologies. Results from using this technique are highly quantitative.

Morphological Matrices provide a formal method for uncovering new product and process possibilities. In applying this technique, users first determine the essential functions of the product or process. Next, the different means by which each of these functions could be satisfied are listed. Finally, the matrix can be used to identify new, reasonable combinations of these means that could result in practical new products or processes. Results of the application of this technique are qualitative in nature. The technique can be used to identify non-obvious, new opportunities for a company. This technique can also be used to identify products and processes that competitors might be developing or considering.

Feedback Models provide a means for tracking the interactions that will connect technical, economic, market, societal, and economic factors as the future unfolds. In using this technique, computer models are developed that mathematically specify the relationships between each of the relevant factors. For example,

advances in technology may result in improved products that may result in increased sales that may provide more funds for further advances in technology. The results of this technique are highly quantitative, but are often used to examine qualitative consequences of trends, events, or decisions. The technique is most commonly used in the formulation of high-level strategies or policy.

Goal Analysts

Definition—Goal analysts believe that the future will be determined by the beliefs and actions of various individuals, organizations, and institutions. The future, therefore, is susceptible to modification and change by these entities. Thus, the future can best be projected by examining the stated and implied goals of various decision makers and trendsetters, by evaluating the extent to which each can affect future trends and events, and by evaluating what the long-term results of their actions will be.

Impact Analysis provides a simple, formal method for taking into account the fact that, in a complex society such as ours, trends, events, and decisions often have consequences that are neither intended nor foreseen. The technique combines the use of left-brain and right-brain thinking to project the secondary, tertiary, and higher-order impacts and implications of such occurrences. Results are qualitative in nature. The technique is often used to analyze potential consequences of projected technical advances or to determine areas in which forecasting efforts could best be directed.

Content Analysis is founded on the concept that the relative importance of social, political, commercial, and economic issues are reflected by the amount of media attention the issue receives. Thus, by measuring changes in such factors as column-inches in newspapers, time allocated on television, and, more recently, numbers of items on the Internet, forecasters can project the direction, nature, and rate of change. In the technical arena, this technique can, to some degree, be used to project advances in new technologies, as well as growing market attraction. The results are often displayed in a quantitative format. However, they are typically used only for qualitative analysis.

Stakeholder Analysis is a formal method for measuring the influence that various individuals and institutions can have on the way the future develops.

- It explicitly identifies those people and organizations, internal and external, that have a “stake” in particular decisions, projects, or programs.

- It analyzes the importance that each individual or group assigns to these issues and the relative influence they may have on developments.

The results from this technique are normally semi-quantitative. It is often used to test the validity of forecasts that might be impacted by unexpected opposition or support.

Patent Analysis is based on the presumption that increased interest in new technologies, together with conviction of their practicality and appeal, will be reflected in increased R&D activity which, in turn, will be reflected by increased patent activity. Thus, it is presumed that one can both identify new technology opportunities and assess the state of development of given technologies by analyzing the pattern of patent application in appropriate fields. Results are often presented in quantified terms; however, their use in decision-making is normally based on a qualitative evaluation.

Counter Punchers

Definition—Counter punchers believe that the future will result from a series of events and actions that are essentially unpredictable and, to a large extent, random. Therefore, one can best deal with the future by identifying a wide range of possible trends and events, by carefully monitoring developments in the technical and social environments, and by maintaining a high degree of flexibility in the planning process.

Scanning, *Monitoring*, and *Tracking* techniques are founded on the observation that, for most new technologies, a finite—often considerable—amount of time is required to traverse the steps between ideation and commercialization. Thus, if one is alert, changes in technology, market, and other business factors can be discerned in time to take advantage of them. All three techniques are employed to identify and evaluate developments that might materially impact the organization's operations and strategies. Although the three techniques are similar in many respects, they differ in purpose, methodology, and degree of focus. *Scanning* seeks to identify any trend or event that might impact the organization and is, therefore, by design, essentially unfocused. *Monitoring* is designed to follow general trends in specified areas and is, thus, more focused than scanning. *Tracking* is designed to carefully follow developments in a limited area and is, consequently, highly focused. Results from each of these techniques can vary between highly quantitative to basically qualitative. However, in general terms, results are less quantitative in scanning activities and more quantitative in tracking activities.

The *Alternate Scenarios* technique provides a structured method for integrating a number of individual forecasts into a series of comprehensive, feasible narratives about how the future might develop. It provides a vehicle for combining many forecasts in a format that allows decision makers to effectively relate the implications of the combination of all forecasts. The results from this technique can range from highly quantitative to purely qualitative, depending on the objectives of the effort, its organization, and purposes to which it will be put. This technique is typically used to assist executives in critical decision-making. Although a single scenario can be used for making decisions, the use of a series of alternate scenarios allows executives to take into account the fact that the future can never be projected with certainty. It also enables determination of how appropriate flexibility can be built into plans.

Monte Carlo Models are computer models that take explicit account of the fact that all projections of future trends and events are, fundamentally, probabilistic in nature. In this technique, all of the steps involved in the development of a new technology are identified, and their interrelationships specified in a mathematical model. Numerical values are assigned to the probability of each event occurring in various ways and to the length of time it will take each event to occur. The model is then run numerous times to determine the probability of various overall outcomes. The results of the technique are highly quantitative, and the technique can be used to project technology development times and patterns, to allocate resources, and to track the development of emerging technologies.

Intuitors

Definition—Intuitors are convinced that the future will be shaped by a complex mixture of inexorable trends, random events, and actions of key individuals and institutions. Because of this complexity, there is no rational technique that can be used to forecast the future. Thus, the best method for projecting future trends and events is to gather as much information as possible and then to depend on subconscious information processing and personal intuition to provide useful insights.

The *Delphi Survey* technique is a method for taking advantage of the talent, experience, and knowledge of a number of experts in a structured manner that allows an exchange of divergent views without direct confrontation. The technique involves initial projections, usually in quantitative terms, of future events. After the initial projections are correlated, participants are asked to explain, anonymously, their differences in a series of follow-up rounds. Results are normally semi-quantitative. The technique can be used to:

- Project future technical, market, and other developments.
- Uncover fundamental differences of opinion.
- Identify non-conventional ideas and concepts.

Nominal Group Conferencing is a formal technique for structuring the input from a number of subject matter experts. The technique is similar in some ways to "brainstorming," but its structure requires all participants to take active part in the process. It also requires participants to use their brains in different ways:

- Individually generate new ideas.
- Silently assess the ideas of others.
- Jointly examine the implications of new ideas with others.
- Formally evaluate a series of options.

The results of employing this technique are typically semi-quantitative. Nominal Group Conferencing is often used to project future developments, uncover new business opportunities, or identify new solutions to old problems.

Structured and *Unstructured Interviews* are methods for gathering and correlating the thoughts and opinions of a collection of experts about how the future will unfold. *Structured Interviews* are similar to traditional opinion polls in that the people conducting the interviews know ahead of time the information they are seeking, and the interview is organized to get this information as efficiently as possible. The use of personal interviews rather than written surveys promotes participation, decreases the probability of misinterpretation, and assists in assessing the qualification of participants. Results are typically quantitative in nature and can be used to project such items as potential market size, rate of technical advance, and general business factors. *Unstructured Interviews*, on the other hand, are used when the subject area to be addressed is less well defined. The interviewer begins each session with only a limited concept of how the interview will be structured. In large measure, each question is based on the answer to the previous question. The interview is essentially free form, and the results can be either qualitative or semi-quantitative. This technique is particularly valuable in identifying key issues, clarifying general concepts, identifying additional experts, and formulating future structured interviews and surveys.

Technology Advantage Management is a technique designed to integrate technology, market, and competitive factors in order to gain advantage from advances in technology. New technologies are examined in light of each of these factors using a two-dimensional, nine-element format called the Technology

Advantage Matrix (TAM). The use of this "map" allows concurrent analysis of each of the factors in terms of business opportunities, organization goals and objectives, and existing and desired programs, resources, and culture. Results range from qualitative to highly quantitative depending on objectives, project organization, and nature of use. The technique is typically used to define strategies, optimize resource allocation, and guide cultural change.

M

Biometrics Authentication

Biometrics authentication* processes fall into three general categories:

- Authentication of a person for entry into an information technology (IT) system.
- Authentication of individual input material, e.g., messages, into an IT system.
- Authentication of the person seeking to extract information from an IT system.

Approaches to authentication are based on:

- What you have, e.g., an electronic passkey, smart card, or token.
- What you know, e.g., a password or personal identification number (PIN).
- Who you are, e.g., physical characteristics and identifiable action patterns.

By direction, this forecast will focus on the last of these three approaches. However, one interesting example of the "what you know" approach (Passface) will be discussed in the section describing facial recognition techniques.

Techniques based on "who you are" are generally referred to as "biometrics" technologies. Biometrics technology involves the automatic identification or identity verification of an individual based on measurable physiological and/or behavioral characteristics. With the introduction of biometrics, there is a shift in focus from a knowledge-based recognition system, i.e., what you have and what you know, toward the presence of a physical or behavioral trait, i.e., who you are.

As discussed below, a number of biometrics techniques are currently being used for authentication purposes, a number are now being added to the active inventory, and a number are early in the R&D process.

* Excerpted from *Review and Forecast of Selected Information Systems Technologies* (Austin, TX: Technology Futures, Inc., 1999), prepared for In-Q-It, pp. 191-205.

Automated biometrics technologies compare a person's unique characteristics against a previously enrolled sample for the purpose of recognizing them, similar to the way our brains function to confirm identity, but on a lesser scale. Typically, biometrics authentication involves three tasks:

- *Enrollment*. Capturing a sample of one or more unique personal characteristics (physiological or behavioral), and then processing the sample to produce a reference for the individual concerned.

- *Association*. Compressing, processing, and comparing with one or more stored samples.

- *Verification*. Interfacing with one or more IT systems to verify information and/or confirm the identity of the enrollee.

Often, authenticated identification of the sender will imply authentication of the input material. In many cases, the techniques utilized to authenticate the person introducing information into the IT system or withdrawing material from the system are similar to the techniques used to gain access to restricted facilities. Commercial biometrics systems for specialized applications such as these have been around for more than 20 years.

Currently, many of the biometrics techniques being used were developed for forensic purposes. The use of these techniques for authentication purposes is usually simpler and less expensive because the system has to make a "one-from-one" match, rather than a "one-from-many" match. That is to say, the system must compare an input sample with an identified stored sample, rather than having to find a match for the input sample from a large number of possible samples.

While early biometrics technologies were developed decades ago, they were normally too expensive and complex for general business use and were therefore limited to highly secure military applications.

As the industry continues to evolve, more recent applications of biometrics have been geared to the private sector. Prices continue to fall, acceptance by the public has increased, and preference over PIN technology is growing. These factors, together with corporations' increasing concern over network security, have contributed to increasing interest in biometrics authentication in the public sector. According to EDN's Senior Technical Editor, Dan Strassberg, "after years of producing relatively high-priced technology for specialized—often government-funded—niches, the biometrics industry is expanding. Several companies have announced dramatically less expensive sensors that enable biometrics to target high-volume applications."[1]

[1] EDN (May 7, 1998).

The technologies required in biometrics authentication fall into to two categories: those involved in capturing the characteristic sample (hardware) and those involved in matching candidate samples with stored samples (software). To forecast future directions of technical advance, both of these categories must be considered.

There are a number of personal characteristics currently being used or considered for biometric authentication. Those based on physiological characteristics include:

- Fingerprints.
- Eye characteristics (retina and iris).
- Facial characteristics.
- Hand geometry (one finger, two fingers, and whole hand).
- Ear characteristics.
- Overall body heat pattern.

Those based on behavioral characteristics include:

- Voice recognition.
- Dynamic signature verification.
- Keystroke dynamics.
- Gesture analysis.

Physiological Characteristics

Fingerprints

For large-scale positive identification applications, no currently available biometrics technique is comparable with fingerprinting. Traditional fingerprint identification techniques are well established, proven, legally accepted, and mature.

Techniques for recording, archiving, and matching fingerprints have been generally available for many years. Although in the past these techniques have been applied principally for forensic identification, there has recently been

increasing interest in using fingerprinting for IT system authentication. The basic principle of fingerprint identification is that the fingers of each person have a pattern of "whorls," "arches," "loops," "hooks," and other shapes unique to that individual. For identification, a single print or a set of prints of a known individual is compared to those of the person to be authenticated. The steps typically involved in fingerprint identification are:

- Collect constant fingerprint characteristics, i.e., those that remain valid for a lifetime such as overall shape, number of lines, and distances between specific points.

- Classify fingerprints, i.e., use main fingerprint shapes to identify them with a group of individuals.

- Identify with certainty, i.e., use fine structure (minutia) of prints to identify a specific individual.

Traditionally, fingerprints have been recorded using ink images on paper. For the purposes of IT authentication, this approach has obvious shortcomings. More recent techniques include:

- *Optic systems*. In this technique, the finger is placed on a platen, usually made of glass, and a picture of the finger is taken. This is the oldest and most mature technology, except for the ink-on-paper technique.

- *Ultrasonic system.* In this technique, the finger is placed on a platen and an ultrasonic image is recorded. Since sound is used for the recording, intimate contact with the platen is not necessary, and usable prints can be recorded even if thin latex gloves are used or if the fingers are dirty. Although this technique has been available for a number of years, acceptance has been limited.

- *Chip-based systems*. In this technique, the finger is placed directly onto a specially designed silicon chip, and the image is recorded electronically. For example, in the capacitive system, sensors register the fingerprint by interacting with the electric field variations produced by the skin's ridges and valleys. The chip then creates an electrical image of the fingerprint. The compact one-chip system is smaller in size than optical systems and requires ultra-low power, consuming less than 1 milliWatt at 5 volts. It also generates a higher quality image than most other identification methods. A working prototype of this imaging technique was demonstrated by Marco Tartagni of the University of Bogata in September 1996 and a paper on the technique is presented in the January 1998 issue of *IEEE Journal of Solid State Circuits.* Development continues at the

University of Bogata and at the SGS-Thompson Innovative Systems Design Group in Berkeley, California.

Eye Characteristics (Retina and Iris)

Retina recognition. This technique utilizes a template of the layer of the blood vessels located at the back of the eye (retina). These retina patterns are scanned by a low-intensity light source via an optical coupler and analyzed for characteristic points within the pattern. According to an article in PC Magazine, retina recognition "is probably the single most secure of all biometrics systems. Both the iris and the retina offer the best security because of the distinctiveness of the patterns and the quality of the capture devices."[2]

Iris imaging and recognition systems. This technique uses a video camera to capture a sample of the pattern of the iris (the colored portion of the eye). The sample may include corona, crypts, filaments, freckles, pits, radial furrows, and striations. Software is used to compare resulting data against stored templates. The technique is less intrusive than retina recognition, requires no intimate contact between user and recorder, and is generally considered to be highly accurate. This technique is considered to be a great source of identification because the iris is stable throughout one's life, it is not susceptible to wear and injury, and it contains a pattern that is unique to an individual. This technique is further advanced and more widely utilized than retina recognition.

Facial Characteristics

The technique is based on the use of certain facial characteristics unique to an individual. Videoconferencing continues to grow, as does the sale of video cameras. With this increase in the number of video cameras, the use of facial recognition as an identification system becomes more attractive to both consumers and business. The public appears to accept the use of this technique at a level that is similar to public acceptance of the use of static photographs.

- *Eigenface*. In this method, a human face is represented as a linear deviation from a mean or average face. It is presumed that every face can be assigned a "degree of fit" to each of the 150 Eigenfaces. The eigenface information is derived from a computer-based analysis of the digital image of a photo. Eigenhead is a three-dimensional version of Eigenface that also analyzes the shape of the head.

- *Facial metrics*. Two approaches are used in the application of this technique: The first compares feature sizes and relationships, such as nose length and the distance between the eyes. The second matches the most

[2] Neil Randall, *PC Magazine* (March 22, 1999).

significant image data, like the size of the nose, with a record of the face stored in a database.

- *Face monitoring*. This technique uses face recognition technology to monitor the attendance of an authenticated end user at a desktop.

- *Facial thermograms*. This technique senses heat patterns in the face caused by the flow of blood under the skin.

- *Passface*. Although this technique utilizes a "what you know" approach rather than the "who you are" approach, it is based on similar theoretical underpinnings as the face recognition techniques discussed above. The system was developed and patented by ID-Arts (Visage Developments, Ltd., United Kingdom) in September 1997. Based on the ability of the human mind to remember faces, the user memorizes four faces and then logs onto an IT system by identifying those faces from a random arrangement of decoy faces. ID-Arts has used this ability to remember and recognize faces as the basis of a "cognometric" identity verification system. As an alternative to biometrics, "cognometrics" requires no special hardware and is inexpensive and user friendly. The Passface System is supported by extensive academic research and by experiments conducted by Professor Hadyn Ellis, Head of the School of Psychology at University of Wales (Cardiff). The research behind this system goes back to the 1970s when efforts on machine recognition of faces began.

Hand Geometry (One Finger/Two Fingers, Palm, and Whole Hand)

The finger/hand geometry techniques are easy to use and tend to appeal to the public because they do not raise many privacy issues. Systems based on these techniques are generally fast and have low data-storage requirements. However, they are less accurate than some other approaches. This type of technology was used for a security system at the 1996 Olympic Games.

- *Finger geometry*. One or two fingers are placed beneath a camera that captures the shapes and lengths of the areas of the finger and the knuckles. To determine identity, the system captures a three-dimensional image and matches the data against the stored templates.

- *Palm recognition*. The palm is placed on a hand reader, and the reader captures the three-dimensional image of the various textures (ridges and other minutiae) of the palm.

- *Hand geometry*. The hand is placed on a hand reader, and the reader captures the three-dimensional image of the fingers and knuckles and stores the data in a template.

Ear Characteristics

At present, there does not appear to be any organization actually using ear shape as a basis of authentication. However, the use of the ear shape to identify a person is being studied by the University of Linz in Austria.

Overall Body Heat Patterns

Although the use of overall body heat patterns has been suggested as a possible authentication technique, there does not appear to be any organization offering a system for commercial use, nor is anyone actually using the technique for authentication.

Behavioral Characteristics

Voice Verification

This technique identifies individuals by comparing their voice/speech patterns with patterns already on file. In using the technique, the system creates a template based upon numerous characteristics, including cadence, pitch, tone, and shape of the larynx. Although the voice pattern is determined to a large extent by the shape of the throat and larynx, this biometrics technique is considered to be a hybrid of physiological and behavioral because there is the possibility that a user could alter his/her speech to generate a false rejection. Background noise is also an issue that could affect the template.

- *Text-dependent system (fixed-text system)*. This system requires a speaker to say a specific set of numbers or words.
- *Text-independent system (free-text system)*. This system creates voiceprints from unconstrained speech and does not require a speaker to say a specific set of numbers or words.
- *Speaker separation*. This system separates overlapping voices from each other and other background noises.
- *Voiceprint*. This system utilizes a representation of the acoustic information found in the voice of a speaker. A time series of spectral-power-density is generated, which shows how the energy in your voice at different frequencies varies versus time as you vocalize a word or phrase.

Dynamic Signature Verification

This system measures the distinguishing features of both the signature and the process of signing. It analyzes the way an end user signs his/her name. It examines such things as speed, stroke order, stroke count, and pressure exerted by a hand holding a pen, as well as the end product of the signature. Although this biometrics technique tends to be more acceptable to the public than most other systems, the verification is considered to be one of the least accurate. This is due to the fact that the technology measures a behavioral characteristic, and users can easily change their signature to generate a false rejection.

In 1998, approximately 9.7 million handwritten digital signatures were applied to electronic commerce using PenOp's technology. PenOp is forecasting that, in 1999, there will be as many as 20 million signatures, as demand for its technology in online transactions continues to grow.

Acoustic emission. This proprietary technique records the movement of the pen tip over the paper fiber to generate acoustic emissions transmitted in the form of stress waves within the material of a writing block beneath the document being signed. Structure-borne elastic waves behave in a similar way to sound waves in the air and can be detected by a sensor attached to the writing block.

Keystroke Dynamics

This technique, currently under development, analyzes typing rhythm when an end user types certain items, such as their user name and password.

Gesture Analysis

Although the use of gesture analysis has been suggested as a possible authentication technique, there does not appear to be any organization offering a system for commercial use, nor is anyone actually using this technique for authentication.

Commercial Off-the-Shelf Status

Dynamic Growth

The commercial biometrics industry is aggressive, dynamic, and growing. According to Erik Bowman, an analyst at CardTech/SecureTech, Inc., as of April 1998, there were roughly 100 vendors, systems integrators, and VARs in the biometrics industry. Jackie Fenn, Vice President and Research Director at Gartner

Group, recently projected that the number of biometrics devices in use is expected to jump from 8,550 in 1996 to more than 50,000 by the end of the decade. Mr. Fenn also predicts that within three or four years about one-third of all corporations will use fingerprint readers or some kind of biometrics device.

In August 1998, the Gartner Group declared biometrics to be one of the top 10 emerging technologies for 1998. Similarly, Biometrics Digest predicted that usage of biometrics would increase from 8,500 devices in use in 1996 to more than 50,000 in the year 2000 across all industries.[3] Revenue for this developing set of technologies was estimated to be $100 million in 1998, and it is predicted that there will be significant gains as product accuracy improves and costs decline. Furthermore, it is projected that the market will double every two years.

In a Washington Technology report, Salomon Smith Barney indicated a U.S. 1997 market for fingerprint verification and biometrics devices of $145 million, and projected a 2001 market of $1 billion with an annual growth rate of 62.1%. This same source indicated a 1997 worldwide government biometrics systems market of $1.5 billion, and a 2001 market of $5 billion with an annual growth rate of 35.1%.

In the larger arena, Frost & Sullivan observed in 1998, that the world automatic identification equipment market has seen a surge in use of automatic identification equipment across all segments: magnetic stripe readers, optical character recognition, smart cards, radio frequency identification (RFID), voice recognition, and biometrics. The company stated that this market has been growing steadily since 1993, at a rate of 22.35%, reaching $2.2 billion in 1996.

Although these projections differ somewhat, they indicate dramatic growth over the last few years and project accelerated growth in the future.

The volatility of the biometrics identification industry is indicated in a single issue of *Biometric Digest*: nine mergers, acquisitions, or new alliances; nine new product announcements; five new joint projects; 12 new major contracts; one company liquidation; and one company name change.[4]

[3] September 1998.
[4] July/August 1998.

Table M.1
Comparison of Biometrics Techniques

ID Type	Strengths	Weaknesses	Cultural Concerns
Fingerprint	Accurate, widely available, cheap, small reader	3% to 7% of population does not have usable	Some countries prohibit fingerprint images for uses other than criminal justice
Iris	Very accurate, image never changes	Perceived as intrusive, cameras expensive	Unacceptable in some cultures
Retina	Highest accuracy	Perceived as intrusive, head must be still during scan	Unacceptable in some cultures
Facial Image	Not considered intrusive, cheap	Less accurate, image changes	Unacceptable where photos are prohibited
Facial Thermogram	Very accurate	Not yet commercially available	May be unacceptable where photos are \ prohibited
Voice	Not considered intrusive, only biometrics for telephone use	Less accurate	None
Hand Geometry	Not considered intrusive, fast, low data storage needs	Less accurate, large reader, may change	None
Signature Dynamics	Not considered intrusive, convenient for financial transactions	Less accurate, multiple samples required	None

Source: Peter Haapaniemi, Executive Magazine (December 1998)

Currently Available Systems

Commercial biometrics authentication systems presently available include the following:

Fingerprints

More than 50 companies currently offer products in the finger scanning and processing area. Among these products are:

- *Optical finger systems*. BigMouse by American Biometric Company, SAFLINK, Sony, Identicator (technology supplied by Indentix), Biometric Access Corporation, SAC, Digital Persona, Mytec, and Compaq.
- *Ultrasonic finger systems*. UltraScan (manufactured by Kodak).
- *Chip-based systems*. Thomson-CSF, Siemens, STMicroelectronics, Harris, Veridicom, Inc., and Who?Vision.
- *Forensic AFIS (automatic fingerprint identification system) software*. Printrak International, Inc. (leading fingerprint recognition systems provider), SAGEM, NEC, Cogent, TRW, and Titan.
- *Civil AFIS applications hardware*. Digital Biometrics, Cross Check, Identicator (technology supplied by Indentix), TRW, and Neurodynamics.

In May 1999, Compaq became the first large mainstream marketer to offer an inexpensive fingerprint reader for corporate computer networks. This product uses optics and software by Indenticator Technology, a division of Indentix.

Eye Characteristics

Iris imaging systems. There are currently only two vendors offering these systems. IriScan, Inc. holds the worldwide patents to the iris scan technology and licenses the technology to Sensar, Inc., which has developed an active application that requires the user to manually focus the camera. Sensar has made developments to IriScan's technology so that the biometrics system automatically locates the user's face and focuses the camera. The IriScan pattern is reduced to a 512-byte code that can be matched against an authenticated scan kept on file to confirm identification. According to marketing vice president Robert van Naarden of Sensar, Inc., "no one else has been using iris scanning as a commercial biometrics technique because the barriers to entry are high."[5] However, investor confidence in the future market of biometrics is exemplified by the receipt of $28 million in funding by Sensar in November 1998. The company has recently stated that it will "pursue government applications" in the future.

Retina scanning. EyeDentify, a company based in Louisiana, holds the patent on retina scanning systems. Their system looks at the vascular pattern of the retina.

[5] Sensar, Inc. brochure.

The company has not made a profit since it was founded in 1976, although the firm has sold equipment to the military for years, says its vice president Buddy Boyett. The company released its first product in 1982, and the second generation in 1989. Robert van Naarden of Sensar, Inc. notes that retinal scanning technology has not had the level of research and development funding that fingerprint imaging technology has had over the past 20 years.

Facial Characteristics

Face recognition. Visionics, Viisage, Miros, Inc., TrueFace ID, Keyware Technologies, NeuraWare, and Siemens. Biometric Access Corporation recently acquired ITI's face recognition technology and is developing an integrated face and finger scan application.

The TrueFace ID system compares individual faces obtained from a live or taped video feed with a database of subjects to identify pre-selected security risks. The technology captures the face of a person, recognizes who that person is, and stores that person's image for future analysis.

Hand Geometry

Hand recognition. Recognition Systems (leading hand geometry recognition biometrics vendor), MicroIdentification, (single-finger geometry), BioMet Partners (two-finger geometry), Digital Biometrics, Inc. (palm-print scanner), and iNTELiTRAK.

Voice Verification

Voice recognition. T-NETIX, ITT, VeriVoice, Veritel, Keyware, Qvoice, Nuance Communications, and the Voice Activated Unlock Technology (VAULT) System by ImagineNation. VAULT uses an electrical analog of a person's voice to verify that a person is truly the user of an access device, usually a PC card or a smart card.

Voice verification algorithm. Noise Cancellation Technologies, Inc. (NCT) licenses ClearSpeech.

Dynamic Signature Verification

Signature dynamics. PenOp, Communication Intelligence Corporation, Cyber SIGN, Inc., SMARTpen. SMARTpen developed the world's first wireless signature device that is targeted for release by LCI Technology Group in the third quarter of 1999. ePad, developed by Interlink Electronics, captures handwritten signatures for use in PC applications.

Keystroke Dynamics

NetNanny's BioPassword is a software system that creates an individual profile according to how a user enters their password, accounting for factors such as hand size, typing speed, and how long keys are held down. Net Nanny acquired the technology from Stanford University. Due to be released in the fall 1999, the company plans to offer the system as a software developer's kit for inclusion in Internet-commerce applications, as well as database access, phone systems, and smart cards.[6]

Technology Forecasts

The market for biometrics authentication systems is growing rapidly, and a number of companies, particularly small ones, are investigating new approaches for accomplishing the authentication process. One of the results of these R&D efforts is the realization that there are a number of physiological and behavioral characteristics that are essentially unique to individuals. In addition to the more commonly-used characteristics such as fingerprint identification and voice recognition, more esoteric patterns such as body heat generation, odors, physical gestures, and ear shapes are being more or less actively examined. (Identification by ear shape actually has a rather long history. In the mid-19th century, the French police used it for forensic identification before fingerprinting became popular.)

At this time, it is difficult to project which of the new technologies will prove to be the most effective and the most widely adopted. However, it is expected that, in at least general terms, security authentication advances will parallel commercial development. Therefore, to project advances in biometrics authentication technology, it will be useful to review industry and technology trends, and examine some emerging technologies of special interest.

Industry Trends

Ever increasing pressure to reduce cost, size, and scanning and processing times. One of the main roadblocks to acceptance of biometrics systems has been their relatively high cost. According to Jackie Fenn, the cost of biometrics technology is coming down fairly dramatically. Gartner believes that the industry is reaching price points where enterprises are becoming interested.[7] For example, in 1994, the smallest fingerprint reader sold by Indentificator Technology was the size of a telephone and sold for $2,000. In 1999, similar units cost less than $99

[6] *PC World* (October 9, 1998).

[7] Gartner Group (December 1998).

and are the size of two sugar cubes. Within five years, it is predicted that a device with similar characteristics may cost as little as $15.

Increased industry standardization. It appears that the issue of compatibility among different software and hardware systems has been emerging as this industry has begun to expand its products and services into the private sector. In April 1998, the BioAPI Consortium and the Human Authentication Application Programming Interface (HA-API) Working Group agreed to merge their biometrics application programming interface (API) development efforts. These two organizations represent a majority of the industry biometrics solution developers, software developers, and systems integrators. As a result of the development of this consortium, all biometrics API efforts were united under a single organization with the goal of developing international industry standards that will receive industry-wide input, collaboration, and review. It is believed that this will, in turn, lead to the development of platforms that integrate all the components needed to build large-scale, mainstream biometrics operating systems and application software. In September 1998, leading biometrics manufacturers formed the International Biometrics Industry Association.

Increased integration. In general, the biometrics authentication industry is characterized by multiple and often complex cross-licensing agreements. For example, SAC Corporation, a Minneapolis-based "biometrics technology development, licensing, and integration company," recently purchased the exclusive rights to utilize a holographic fingerprinting technology from ImEdge Technology. They also signed technology-licensing agreements with OPUS Biometric Technology, Sense Technologies, and BIOMETRICS 2000.COM.

Another example of cross licensing is offered by the SecureSuite system offered by I/O Software. As a result of its compatibility with Entrust-Ready software, users and developers of Entrust/PKI ready applications can make use of the biometrics authentication services provided by SecureSite. This compatibility will allow access to a wide range of biometric technology including the following components:

- FingerLoc fingerprint sensor from AuthenTec.
- Veridicom silicon fingerprint sensor from BII.
- Fingerpass optical fingerprint scanner from Fujitsu.
- System 2100 iris scanner from IriScan.
- Keyboard with integrated fingerprint scanner from Key Source.
- INNOSCAN tactile sense fingerprint scanner from MAG.

- FPR-DT/Mk-11 optical fingerprint scanner from Mitsubishi.
- FIU-500 optical fingerprint scanner from Sony.
- FingerChip thermal sensor from Thompson-CSF.
- VD-100 finger geometry sensor from Toshiba/TEC.
- FPS100 silicon fingerprint sensor from Veridicom.
- TactileSense fingerprint scanner from Who?Vision, the industry's first fingerprint authorization system to use an electroloptical sensor to measure the electric field between the ridges and valleys that make up a fingerprint.
- Smart cards from a number of different suppliers.

Other recent mergers include:

- SAFLINK merged with HAAP/BioAPI (June 1999).
- Thomson-CSF Semiconductors Specifiques (TCS), a biometrics developer and semiconductor company, announced its strategic partnership with Neurodynamic. This partnership joins Thomson's silicon sensor technology with Neurodynamic's fingerprint identification system software package (May 1999).

Recognition of the need for public acceptance. For biometrics technology to gain wide acceptance in the consumer and business markets, several issues will need to be taken into consideration. The first is public acceptance of the replacement of PINs and other recognition techniques with biometrics technology. With the issue of identity verification comes the issue of an individual's right to privacy. The industry will need to develop products that improve security without encumbering users and that provide a high level of convenience to customers.

Other factors that must be considered are the legal issues involved with introducing biometrics into society. Laws requiring a signature or photograph on certain documents will have to allow for the substitution of biometrics identity-verification techniques. Also, as biometrics technology becomes more widespread, laws concerning privacy will be an area that must be considered.

Technology Trends

In addition to the general trends noted above, there are a number of technology trends.

Increasing use of multiple authentication techniques. To accomplish ever-higher levels of security, many companies are now developing systems that apply several authentication approaches simultaneously, e.g., spoken passwords combined with speech identification. More efficient algorithms are also being developed that will allow more factors to be matched in a given period of time.

The integration of several physiological and/or behavioral characteristics to provide multiple means of identity verification can enhance authentication reliability. Such integration takes advantage of the capabilities of each biometrics characteristic and overcomes some of the limitations of a single biometrics process. When tested independently, identity established by such an integrated system has proven to be more reliable than identity established by individual biometrics. These multiple characteristic processes also provide for increased security. To meet targeted reliability thresholds, it is anticipated that the industry will look toward products that will incorporate multiple biometrics. Examples of multi-biometrics efforts within the industry include:

- Electronics Identification, Inc. (EI^2) has created an electronic identification system that combines radio frequency and biometrics imaging technologies to digitally encode fingerprints, photographs, and personal details on a microchip using the EI^2 compression technology. This system is called the Electronic Personnel Identification and Control System (e*PICS).

- PenOp is developing a signature authentication system that will allow consumers and businesses to legally execute a document and positively identify a signatory when transacting business online. This combined approach will simultaneously capture two biometrics inputs—an IrisCode record and a handwritten digital signature.

- In July 1998, the National Registry, Inc. formed a strategic alliance with WebLink Communications, Inc. to develop and market SAFsite, a security system for the Internet that is based on multi-biometrics identification and authentication. The organization also changed its name to SAFLINK as part of the company's efforts to move from a biometrics technology company (focusing solely on fingerprint technology) to a network security company specializing in multi-biometrics identification and authentication software. This technology combines speaker recognition, facial imaging, and fingerprint verification.

- In 1998, Miros, Inc. formed a partnership with Veritel Corporation to integrate biometrics solutions for computer and network security. The partnership calls for cross licensing the Miros product TrueFace face recognition system with Veritel's AuthentiGate voice verification product.

- KeyTronics established an agreement with Identicator Technology (acquired by Identix in November 1998) to build computer keyboards, mice, and other input devices with embedded fingerprint scanners. These scanners will incorporate Identificator's fingerprint identification technology. SAFLINK (formerly known as The National Registry, Inc.) will coordinate the efforts of Biometric Identification, Inc. and Key Source International to integrate Bio ID silicon sensor fingerprint verification technology into Key Source computer keyboards.

- Polaroid Corporation's Biometrics Division is collaborating with Key Source Australia to integrate Polaroid's PFS-100 optical sensor and finger image authentication technology into Key Source computer keyboards.

Growing industry for smart cards. As the mainstream use of biometrics technology continues to grow, the use of smart cards is gaining wider acceptance. The Smart Card Industry Association reports that industry revenues are expected to more than triple from almost $16 million in 1996 to $50 million by 1999. Smart cards store your biometrics "template" so that you can take your identification information with you, rather than keeping this information on a centralized database system. An alternate to this would involve both the use of the smart card with a biometrics technology to log on to the system. The American Biometric Company has looked at this issue and has come up with an integrated system of the smart card with user authentication. Similarly, Zephyr Biometric, Inc. has designed a software program (File LockE) to work with smart cards, biometrics technologies, and encryption technologies to provide security for PCs, local area networks (LANs), wide area networks (WANs), and websites.

Interesting New Technology Developments

Holographic fingerprint imaging technology. One new technology that holds considerable possibility is edge-lit holography fingerprint scanning which promises to be smaller, cheaper, and faster than current scanning methods. ImEdge Corporation was one of the pioneers in this technology. ImEdge was started in 1991 to commercialize the unique advantages of edge-lit and waveguide holograms. They are a developer, licensor, and manufacturer of specialized holograms that act as thin illumination sources, and they also hold exclusive licenses to waveguide hologram patents. In June 1998, SAC acquired ImEdge's holographic fingerprint technology. Another company involved with holographic optics for fingerprint scanning is Advanced Precision Technology, Inc. In 1998, the company released the APrintT HoloPass device. The HoloPass incorporates APT's patented holographic optics, and was co-developed with Stanford Research Institute.

In 1998, AuthX, Inc. introduced a "self-authenticating" technology for cards and documents. The system uses information from a photograph and text to create an

encrypted signature that is applied to the document. This technique stores the picture and text as well as the biometrics information into what is called the "AuthX signature." This signature "can unambiguously link the bearer and the document while confirming that it has not been altered or forged," according to Richard Bock, president of AuthX.

Facial thermographs. Still in the test phase as of early 1999, this technology uses an infrared camera to capture heat emission patterns. The underlying vascular system of the human face produces a unique signature when heat passes through the facial tissue. Technology Recognition Systems of Alexandria, Virginia is currently testing this technology.

Hand veins. Currently in development by the British Technology Group, this method scans the vein pattern on the back of the hand, creating a digital template that can be matched against stored patterns. Vein biometrics records subcutaneous infrared absorption patterns. These images are "binarized, compressed, and stored within a relational database of two-dimensional vein images."

Layered biometrics verification. Developed and released in 1998 by Keyware Technologies, Layered Biometric Verification (LBV) is the first security server to integrate multiple biometrics verification technologies into one solution. The LBV server allows the user to choose biometrics techniques that best meet their current and future security needs. The LBV has received support from companies such as American Microdevice Manufacturing, Belgacom Alert Services, Bull Information Systems, STMicroelectronics, Schlumberger Smart Cards & Terminals, Security Dynamics Technologies, Inc., CRYPTOCard, and SAC Technologies, Inc.

Conclusion

Because of the dynamic nature of the biometrics authentication industry, the intelligence community has, and will have available to it, a wide variety of commercial off-the-shelf (COTS) biometrics products and services. However, selecting a biometrics system typically involves balancing the sensitivity of the data against the cost of protecting it, the time and effort required for that protection, and the likelihood that the authentication technology will be accepted by its users. Therefore, to achieve the level of security required by the community, special modifications to COTS technologies may be required. Moreover, the ever-changing nature of the industry and the very aggressive R&D activities that characterize it, the community will require an effective surveillance program to keep up-to-date on the technological state of the art.