A Model for the Mobility of NAFTA Professionals

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INTRODUCTION.

Technological change plays a critical role in permitting and stimulating economic growth. This may seem self-evident if one were to ponder the effects which the invention of the wheel, the wedge, and the lever have had on the advent of international trade agreements. Yet, technology and business share a highly dependent, mutually serving relationship that will ultimately determine the success of the NAFTA experiment. The objective of the international research projects at *Centro de Enseñanza Técnica Y Superior* (CETYS University) is to propose standard methodology that will facilitate the mobility of U.S. and Mexican professionals across international boundaries as a means towards commercializing intellectual products. A definition for the NAFTA client is assumed, then held constant in order to simplify our studies. It is the purpose of our methodology to make the best use of existing infrastructure and accepted standards from each participating country. CETYS research begins with the engineering profession because of it's direct association with economic growth and the international acceptance of an existing U.S. standard. Applicable data for the design of standards in the remaining NAFTA professions will be discovered.

THE BUSINESS OF PROFESSIONAL ACCOUNTABILITY

THE PRODUCT. An engineer does not produce any solid object. An engineer produces the information required to produce any solid object. The value of engineering information is often measured by the client as the amount of risk that is removed from a business venture through the application of engineering information. Information has no mass and travels at close to the speed of light. By the year 2000, the total output of all information services and products is expected to exceed 1 trillion dollars. Infrastructure and standards currently in legislation will do for the technological revolution what the intercontinental railroad did for the industrial revolution. The exchange of information is the medium of technological change and therefore, economic growth.

THE VENDOR. In many industries, the license to sell professional services is issued against reliable regulatory criteria. The professional license carries significant financial benefit to the holder and can be removed or penalized upon a due process conviction for negligence, incompetence, fraud, or breach of contract. As with an automobile driving license, these characteristics create an economic condition in which it is most profitable for each individual to practice high integrity rather than low integrity in the trade of professional services. The holder of a professional license accepts risk for the services delivered to the client. Industries such as the medical arts, engineering, accounting, and law, require that this economic condition exists in order to safeguard the health and welfare of people and property, therefore, investors and their investments.

THE CLIENT. The end-user of an information product is always an investor; the general public, the employer, financial institutions, and insurance companies all ultimately fall into this category. All investors calculate the risk that a project will be successful. All investors distribute risk among the beneficiaries of a business venture as a means of assuring accountability, thus optimizing the ratio of risk against return. During a recent budget review, a Northwestern U.S. State Legislature questioned the need to continue funding their Engineering Licensing Board. The insurance industry threatened to not insure any new projects in the State unless engineers were deemed competent. A bank will not lend money to a project that cannot be insured, and the competent engineer must be paid a prevailing wage during the design phase in order to accept a project. In this case, the insurance company drives economic development as an investor that requires an information product to be applied in the calculation of risk. It is clearly of best interest to respond to the conditions that regulate the flow of monetary and intellectual investment capital.

THE CURRENCY. A "standard" is something established for use as a rule or basis of comparison in measuring or judging capacity, quantity, content, value, or quality. A standard is that which is recognized as correct through common consent by those most competent to decide. The standard bearers are those that participate, study, and refine towards perfection, the accepted standard. Where a standard exists, the exchange of information, trade, and innovation flourish. The width of a railroad track, the Metric System, and The Microsoft Corporation DOS platforms are among many accepted standard currencies of trade that ultimately support the value of a minted coin or printed bank note.

NO INTERNATIONAL COMITY FOR ENGINEERING PROFESSIONALS

A FLEXIBLE THREE STANDARD SYSTEM. The U.S. engineer is not required to be licensed in order to be employed as an engineer, however, the employer is liable for proper engineering judgment of the employee. If an engineer seeks to enter into private practice or perform public works, they must, by law, become registered in their discipline. The process of professional practice for engineers in the U.S. varies somewhat with each State Board of Engineering but always takes into account three independent standards of competence; education, experience, and examination. The education standard is defined by the American Board of Engineering Technology (ABET) through the analysis of the student entering an engineering program, the academic accomplishment of the professors of a program, and an assessment of available educational resources. Upon compliance with these and other parameters, ABET issues an accreditation of the engineering program. The experience standard is defined by each State Government all of which support an Engineering Board and license enforcement authority. The experience standard varies with education attained but relies on a peer review process by several licensed engineers that can verify, against their own license, the candidate's level of professional development. In most U.S. States an individual with a Bachelor of Sciences in an Engineering discipline is required to have 6 years of professional work experience at a defined level of responsibility. The examination standard is defined by the National Council of Engineering Examiners and Surveyors (NCEES) in a two part process that measures both breadth of engineering knowledge as well as depth of engineering knowledge. There is some flexibility among the three standards such that an increase in one standard can compensate for a lacking in another.. All three standards are applied and at least two of the three standard will always be in full, if not excess, compliance. This is an important benefit of the three standard system which will facilitate application on the international scale. The Japan Transfer of Technology Association has acknowledged that the U.S. three standard system may become internationalized in the near future. Italy and Saudi Arabia have also participated in the U.S. Engineering Registration system.

CANADIAN ENGINEERING REGISTRATION. Canada awards a professional engineering licenses after an exit exam from an accredited university, four years of work experience, and good moral character. Accreditation is performed by the Canadian Engineering Accreditation Board (CEAB) of the Canadian Council of Professional Engineers (CCPE). The CEAB and ABET have a long standing process of mutual verification and continue to monitor each other's accreditation systems, policies, and procedures. The CCPE verifies work experience and Canadian Society defines good moral character. There is no comity between Canada and the U.S. for professional licensure. Between the two, education is standardized, the experience standard can be adjusted, but the examination standard differs.

MEXICAN ENGINEERING REGISTRATION. Mexico awards the professional engineering license after an exit exam or thesis in addition to the successful completion of an engineering program accredited by the Federal Secretary of Education. The exit exam is written and evaluated by the professors of the accredited institution. The Mexican engineer is not required to be registered to practice before becoming employed as an engineer, however, there is a social and professional distinction between a *Pasante* (one who passed all subjects) and a *Titulado* (one who holds the title of *"Ingeníero"*). The Mexican accreditation system requires that the student perform community service. Each educational institution also has the freedom to define additional requirements for graduation. CETYS University requires social service within the educational institution, foreign language proficiency, and professional practice in local industry in addition to community service requirements. CETYS is currently the only Mexican university that also accepts the NCEES EIT exam in lieu of the general knowledge exit exam. As a result of the NAFTA, Mexico has created an accreditation board, *Consejo de Acreditación de la Enseñanza de la Ingeniería (CACEI)*, that would fall into the same system of verification as ABET and CEAB. As of this writing, the CACEI is not yet an operational standard since it has only accredited two out of about 300 engineering programs in Mexico. There is no comity between Mexico and the U.S. for professional practice in engineering. Between the two, examination criteria are not standard, experience criteria can be adjusted, and an education standard is not yet operational.

THE NAFTA TREATY AND THE TRADE OF ENGINEERING SERVICES

NAFTA reduces tariffs and restrictions on the trade of both goods and services - engineering is a specific NAFTA service. The Mutual Recognition Document for Engineering Professionals between Canada, Mexico, and the United States was signed on June 5, 1995 and sets out to define criteria for engineering mobility. The Mutual Recognition Document excludes the competency examination standard in lieu of a requirement that a licensed engineer from the home jurisdiction has between 15 and 19 years of acceptable work experience prior to being fully recognized by a host jurisdiction. The Mutual recognition document assumes that all schools will be equally accredited and sets out non-specific criteria for knowledge of host language, laws, and customs prior to acceptance in the host nation. The following chart represents the status of the current NAFTA mutual recognition model for engineering professionals and the home license criteria of each country. Note that no two out of three standards are shared by all countries.

<u>With respect to the NAFTA client:</u>

	EDUCATION (STANDARD)	(?)
NAFTA	EXPERIENCE (15-19 YRS)	(A)
	EXAMINATION	(?)
	LANGUAGE (no standard)	(?)
	EDUCATION (CACEI)	(?)
MEXICO	EXPERIENCE	(A)
	EXAMINATION (institutional)	(?)
	EDUCATION (CEAB)	(S)
CANADA	EXPERIENCE (CCPE)	(A)
	EXAMINATION (CEAB)	(?)
	EDUCATION (ABET)	(S)
UNITED STATES	EXPERIENCE (State Boards)	(A)
	EXAMINATION (NCEES)	(S)

(S) = accepted Standard, (A) = Adjustable standard, (?) = standard not mutually recognized, not yet fully defined, or requires additional infrastructure.

The NAFTA Mutual Recognition Document reduces the flexibility of a three standard system while excluding a large population of engineers that would best serve the intentions of the NAFTA document. 15 - 19 years ago, the computer and bi-cultural media barely existed in either the work environment or the educational systems. The engineering tasks of the future will require youth, mobility, computer literacy, modern quality training, professional accountability, technical competence, bi-culturalism, and bi-linguality. The Mutual Recognition Document was ratified by the NAFTA representative agencies but is under significant criticism by the U.S. State

Engineering Boards for failing to demonstrate engineering competence through standard examination. So far, the NAFTA process of mutual recognition remains unproven by engineers, industry, investors, and insurance companies. Therefore, one working standard for professional mobility does not yet exist and a void remains to be filled. NAFTA does not supersede existing laws of any country nor prohibits a foreign engineer from becoming registered directly in the host country, if applicable.

SUPPLY THE CLIENT... An opportunity area for the border universities is to re-study the issue with respect to the border culture. The objective of the study will be to create a working professional mobility standard that is first acceptable to the border clients and is then expanded into agreement with relevant licensing boards, governments, and societies.

In the NAFTA era;

1. Individual engineers may be 'accredited' by standard examination.

2. The lowest common experience standard of all three countries is from the U.S. which requires 6 years of responsible charge experience if the engineer has graduated from a non-ABET accredited engineering program.

3. A mutual educational accreditation should be developed over time against fundamental benchmarks set, measured, and modified through standard examination. Bearers of the standard will participate the evolution of the standard.

In the three NAFTA countries, each engineering licensing system effectively addresses the needs of the respective client society. To force a common education accreditation may produce a condition that does not effectively meet the needs of any of the three societies. With the development of one set of common examinations, at least two of the three standards will fall within the capabilities of existing infrastructure of all NAFTA participants while preserving the autonomy of each other's educational objectives.

The following chart demonstrates the CETYS model for professional mobility. Note that two of the three standards fall into place of existing laws and infrastructure. The feedback loop promotes a cooperative development of an education standard as opposed to a cooperative burden of mutual accreditation. 9 - 13 years are saved against the current NAFTA model for full mutual recognition of engineering professionals.

	EDUCATION	
NAFTA	EXPERIENCE (6 yrs host review + home lic.)	(S)
	EXAMINATION (NCEES model, native lang.)	(S)
	LANGUAGE (Exam, Edu., Exp.)	(S)
	EDUCATION (CACEI)	
MEXICO	EXPERIENCE	(S)
	EXAMINATION	(S)
	EDUCATION (CEAB)	
CANADA	EXPERIENCE	(S)
	EXAMINATION	(S)
	EDUCATION (ABET)	
UNITED STATES	EXPERIENCE	(S)
	EXAMINATION	(S)

...WITH A SIMPLE MEASUREMENT DEVICE; The NCEES Engineer-In-Training exam (EIT certification in California and the Fundamentals of Engineering (FE) certification in other states) and the Professional Engineering exam (PE registration) are sufficiently durable points of comparison in North America for fundamental engineering knowledge and professional engineering competency. It has been discovered that the Mexican engineering education is comparable with a U.S. engineering education based on the first of these two standard measurement devices. Within the context of NAFTA, every government, industry, bank, insurance company, and educational accreditation council can theoretically recognize the results of these exams. EIT competency examination results, published by the NCEES, can be used as input to the university system towards the development of a common educational standard. By virtue of the feedback loop, the universal application of competency examinations represents the critical element of any Total Quality Management Systems (TQMS), re-engineering theory, or ISO 9000 standard that have proven effective in the multi-national activities of other industries.

Presently, the EIT examination is 8 hours long and contains 210 questions covering 10 engineering subjects that are common to most engineering education programs in the United States and, conveniently, Mexico and Canada. The objective of the EIT is to examine the breadth of fundamental engineering knowledge. In the near future, the EIT will be changed to include two additional subjects and a means to measure some depth of fundamental knowledge within the engineering discipline of the examinee. The Professional Engineering (PE) exams are also 8 hours long but require the earn about 48 points from a selection of 20 one hour problems (each worth 10 points) specific to the discipline of the examinee. The objective of the PE exam is to measures the depth of an engineer's knowledge.

BEARING THE STANDARD:

PARTICIPATE IN THE STANDARD. CETYS University has completed three cycles of preparing Mexican educated engineers to present the EIT examination. Each theme is assigned to one professor who has recently taught a full length course in the same theme. Each professor is responsible for studying the NCEES objectives and presenting the relevant material within the given class time of five to six hours. Homework problems are assigned by the professors based on their past classroom experience. The total class time of the CETYS EIT preparation course is about 70 hours including 20 hours of timed examinations specifically developed to simulate actual exam conditions. As of this writing, 160 Mexican engineers have taken the EIT exam through the CETYS program. The EIT exam is usually given in April and October while results are available for the previous exam in August and February.

STUDY THE STANDARD. The present CETYS program cycle studies over 125 students representing more than 16 Mexican educational institutions. Data is collected during the preparation course, compared with the previous students, and analyzed. Variables such as years since graduation, major, grade point average, English language proficiency, entrance exam scores, weekly exam scores, final exam scores, and EIT exam results are controlled as best as possible while correlation is actively sought. Data is used to improve methodology in both the EIT preparation and the full length courses. Due to financial restrictions, our ability to control some desirable variables in this research is limited by the need to offer a commercially viable service to the EIT exam preparation clients. On the other hand, this condition also provides us with a somewhat fair and voluntary sample of Mexican engineers to study. For example: because we charge a tuition we cannot force a student to sit for the entire duration of a controlled 8 hour practice exam nor are we at liberty to stack the cards and send only our best onto the World Stage of the EIT success history. Our sample enters the EIT with a similar previous knowledge of success probability available to any EIT candidate through commercially available preparation methods.

For the October, 1995 exam, 19,729 engineers in the U.S. including 2449 from the State of California took the EIT (FE) examination. The passing average for the U.S. was 68% and for California; 60%. Of the 46 Mexican educated engineers that took this exam in California and for whom results are available, 33 were from the CETYS preparation course and 17 of these received their education at CETYS University. On the April 1995 exam, the CETYS educated engineers had an 86% pass ratio and for October 1995, this fell to 58%. A total of 26 engineers educated at CETYS have now taken the EIT exam while 18 of those passed the exam - the total success ratio for CETYS, over two exam cycles is 69%. The pass ratio of all ABET accredited schools in the U.S. over the same two exams was about 73%. The success ratio for non-ABET accredited schools in California was about 32%. Of the 229 engineers that where educated in countries other than the U.S., Mexico, or Canada, that took the EIT in California, 38% were successful. Of the 13 engineers from Mexico that did not participate in the CETYS preparation program and who took the exam in California, 38% passed. For 6 Canadians represented, 5 passed (83%). A distinction between first time examines and second or third time efforts is not made in the above statistics. The EIT exam is only given in English.

Among our conclusions for a foreign language exam is that the general population of the Mexican border engineers consistently exceed the passing average of a non-ABET accredited engineering program from the State of California if they are prepared by our methods. Although the sample size differs greatly, the results for CETYS graduates are comparable to the average pass ratio of all engineers who presented the EIT in the State of California over the same two cycles and within 5% of U.S. ABET accredited schools. An exam result breakdown from both exams indicates a consistent weakness in chemistry and greatest strength in mathematics for the Mexican students. For the April 1995 exam, CETYS course students performed above the United States in 7 out of 10 categories of engineering fundamentals. For the October exam, CETYS results were combined with the results of at least three other Mexican institutions who equaled or bettered the U.S. in 3 out of 10 categories and California in 5 out of 10 categories. A further breakdown of comparisons between each major also yield valuable information about academic preparation in the chosen field. This data is currently being used to further enhance the quality of the CETYS Engineering programs. The EIT was never intended to qualify an educational institution, therefore, these results do not say everything about a university. The exam does determine the ability of an individual engineer to accurately solve engineering problems under a time restraint. We propose that this is precisely the information that the assumed NAFTA client seeks.

REFINE THE STANDARD. Current and past efforts to quantify an EIT language disparity factor have been, at best, inconclusive. An EIT specific disparity factor would help us to quantify a zero English language proficiency condition that would exist farther south of the border. Language proficiency not only differs by context but also by medium; reading, writing, speaking, and listening. Due to a high level of bi-lingual reading ability in the border environment and variation in educational background, it is very difficult to measure language disparity for technical competency exams. The heavy use of charts, equations, and graphs on simulated EIT exams further complicates the isolation of language proficiency indicators. However, it does appears that the Mexican border student suffers little loss of accuracy when interpreting an engineering problem expressed in English. Observation and interviews indicate that a disadvantage may occur in the amount of time that the student needs to comprehend an English language problem. It is an objective of our program to over-prepare the students so that they may have the luxury of skipping an especially wordy problem on the EIT exam. Since only the student knows how much difficulty they themselves have with reading technical information expressed in English, we feel that self evaluation is the most reliable indicator available to us. Self-assessments of EIT material reading proficiency are compared with the same from EIT students that also possess a Test Of English as a Foreign Language (TOEFL) score. We can then predict a probable TOEFL score for each student that corresponds to EIT material reading proficiency. Large amounts of data may compensate for the variations in technical language proficiencies and expose a trend that may link language proficiency to the time lost comprehending a typical EIT problem. Another current study rates the complexity of English used on sample problems, on a scale of 1 to 5, from subjects common to the highest number of engineers. The success rate on these questions are then plotted against language complexity. Results from these studies should be available in the near future. It is also our desire to be able to recommend a minimum level of readily available language education to the Mexican examination candidates.

APPLICATION OF SCALE. We expect that the feasibility of large scale application of standardized competency exams in Mexico will almost entirely rest on the language issue. Mexico has excellent infrastructure for English language education and excellent infrastructure for engineering education, but very little infrastructure for engineering education in English. The inverse is true for the United States and Canada towards the intended penetration of Latin American markets. Many generations will pass before duality is achieved. Future analysis should compare the time and cost of NCEES issuing Spanish language exams against the same for all Mexican engineers developing a competitive proficiency in the English language without the benefit of immersion.

THE EXPERIENCE STANDARD. With competency exam standards established and the educational standard under statistical development, various combinations of work experience and mobility can be explored. Controlled mobility should be the preferred mechanism of compliance with NAFTA requirements for knowledge of language, laws, and customs of the host country. Existing U.S. and Canadian criteria stipulate, with some exceptions, that a junior engineer work under an engineer licensed to practice in the relevant jurisdiction. Many U.S. State Engineering Boards routinely acknowledge a foreign engineer's experience working under another foreign engineer who is licensed to practice engineering in that same foreign country. Procedures can now be established based on an adjustable 6 year experience standard for a U.S. junior engineer working under a licensed Mexican engineer in Mexico towards their application for a Canadian license, or a Mexican junior engineer working under a licensed Canadian in Canada towards their application for a U.S. license, etc. If these combinations are individually acceptable by each NAFTA Country, a working model would then exist for the intended NAFTA Professional Engineering license.

IN CONCLUSION: CLIENT. The revocability of the professional license creates the economic condition that minimizes the risk of low integrity business practice, however, investors still need an independent standard measure of language and professional competency in order to fully assess risk. Nobody can solve one equation for two unknowns, therefore, it is recommended that native language NCEES style examinations become an accepted standard that should be attached to the respective foreign language proficiency standard towards professional registration for all NAFTA parties. It is not necessary that 100% language proficiency is required but only that those calculating risk posses a number that accurately quantifies an individual's ability to communicate in the host country's language of commerce. From my personal experience in Mexico, a foreign language course is best served by simultaneous immersion and mobility should not be severely limited by a perceived language barrier. Humans, and perhaps most mammals, will find ways to communicate by whatever means are available to them. Adjustments in schedules, task assignments, quality control, financial compensation, or use of translators can accommodate the barrier presented by cousin languages. It is further recommended that the language competency standard follow the same flexible model for education, experience, and examination. Existing programs and infrastructure in the University system can then service this critical NAFTA component through the many fine student interchange programs that are available.

The following represents an example of consistent application of the flexible three standard system with another components of NAFTA competency. Note best use of existing infrastructure.

DEFINE FOREIGN LANGUAGE COMPETENCY

EDUCATION: (classroom language course)
EXPERIENCE: (immersion, student interchange, temporary license.)
EXAMINATION: (standard foreign language examination.)

IN CONCLUSION; VENDOR. The professional engineer who seeks to qualify on the global market is provided with a set of clear yet flexible goals of known value available from existing infrastructure. The experience of creating a successful mobility standard for engineering service providers will greatly accelerate the application of competency models for other professions. However, a flexible system of the three mutually inclusive standards in education, experience, and examination should be maintained. Language proficiency exams will quantify communication risks. Many standard exams that can provide feedback to the education system currently exist or can be developed for most professions, including but not limited to: accountants, computer scientists, architects, managers, business consultants, and teachers. The small, medium, and large vendor is now at the same advantage to compete on the global market as the largest corporations have been for years.

IN CONCLUSION; PRODUCT: Once a full series of mutual recognition standards are identified, the geographic, cultural, and pre-existing infrastructure of the border universities can be fully exploited. A strong cross border alliance can provide large, medium, small and micro businesses with a point-to-point contact into the other country. Each border university possesses a great amount of information about their own country in addition to close contact with their own communities and government agencies. Language and cultural translation and interchange are information service products that can rise naturally out of a close association between two border universities. Mutual acceptance of professors, students, and personnel will be a very small road to build for the professionals of each nation to transcend information barriers.

APPENDIX A

EIT exam subject breakdown:

Note: The April 1996 EIT was the last that will use this format. Future exams will include the two additional subjects of computers and ethics. Also, future exams will permit an engineer to take a career specific afternoon section.

MORNING SESSION (4 hours, each question worth 1 point)

SUBJECT	NUMBER OF PROBLEMS
Mathematics	20
Electric Circuits	14
Fluid Mechanics	14
Thermodynamics	14
Dynamics	14
Statics	14
Chemistry	14
Mechanics of Materials	11
Engineering Economics	11
Material Sciences/Structure of Matter	11
TOTAL	140 X 1 point = 140

AFTERNOON SESSION (4 hours, each question worth 2 point)

Engineering Mechanics	20
Applied Mathematics	20
Electric Circuits	10
Engineering Economics	10
Thermodynamics and Fluid Mechanics	10

TOTAL 70 X 2 points = 140

APPENDIX B: October 1995 EIT performance summary;

State of California and National EIT Exam results: Note that the EIT exam success is determined on a pass/fail basis and is not designed to measure the total quality of an engineering program. These results do not reflect who took a review course, years since graduation, prior attempts to pass examination, Engineering Major, GPA, points earned above/below passing, or English Language proficiency.

California; SCHOOL	# TESTED	PASSING %
CSUS CHICO	25	75
CSUS FRESNO	51	49
CSUS FULLERTON	52	58
CSUS NORTHRIDGE	49	57
CSUS LONG BEACH	111	50
CSUS LOS ANGELES	53	55
CAL POLY POMONA	195	57
CAL POLY S.L.O.	157	78
CSUS SACRMNTO	141	53
UC BERKELEY	84	98
UC DAVIS	87	85
UC IRVINE	48	90
UC LOS ANGELES	62	89
UC SAN DIEGO	57	96
UC SANTA BARBARA	13	85
UC SANTA CRUZ	1	100
USC	49	65
UOP	17	76
CAL. TECH	6	100
CAL MARITIME ACAD	12	58
COGSWELL COL.	1	0
HARVEY MUDD	2	100
HUMBOLT ST. U.	35	74
LOYOLA MARYMNT.	11	55
NAVAL POST. SCHOOL	8	100
NORTHROP UNIV.	2	0

National;

All examinees	19,729	68.5%
1st time exam	14,222	80.0%
ABET Accred.	15,408	74.6%

Source: National Council of Examiners for Engineering and Surveying.

SDSU	115	51
SAN JOSE U.	103	59
SFSU	49	69
SANTA CLARA U.	21	62
STANFORD UNIV.	11	100
U.S. INT. U.	7	29
NON-ABET ACCRED	**22**	**32**
NO EDU/ EXP. ONLY	22	14
OUTSIDE CA/ USA	205	53
CANADA	6	83
MEXICO	13	38
MX/CETYS PROG. Totl	**33**	**52**
MX/(CETYS GRADS)*	**17**	**58**
OTHER/EDUC. OUTSIDE USA	229	38

Source; California Board for Registration of Professional engineers and Land Surveyors
()* CETYS Department of academic records. CETYS educated within program total of 33.

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