AC 2008-1993: SUMMER ON-SITE IMMERSION IN FRENCH LANGUAGE AND ENGINEERING

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Abstract

Globalization will require production of engineers with not only technical but also foreign language competence. We describe a new summer program at a French engineering school, CPE-Lyon, which provides both French language instruction and engineering laboratory experience. The desired result is an immersion in a foreign culture and language as well as demonstrated use of a second language as a future professional tool, not just a retrospective pathway to a past literature. This new six week for-credit classroom plus laboratory program is a major revision of an earlier CPE-Lyon four week, non-credit language and technology classroom experience begun in 2000[1].

Introduction

This paper presents initial US student summer experiences in an overseas, foreign language immersion setting which involves, in parallel, French language instruction, technical lectures, and a chemistry/chemical engineering laboratory course. As both foreign language instruction and undergraduate engineering laboratories are widely available at engineering campuses around the world, this configuration would seem to be eminently transportable. We frame our report in light of US engineering education needs, then present our particular French experience which illustrates a novel pedagogical approach.

US Engineering education needs

The combination of foreign language instruction with an engineering laboratory course is not intuitive, but is consistent with the need for an integrative approach to undergraduate education. Such integration to achieve the roundly educated engineer of the ABET EC 2000 criteria is consistent with Eric Ashby's early claim[2] in Technology and the Academics that "The path to culture should be through a man's specialism, not by by-passing it… The *sine qua non* for a man who desires to be cultured is a deep and enduring enthusiasm to do one thing excellently." We propose that Ashby would include the integration of language and cultures into an engineering education.

Current US engineering education requires contributions from both science and engineering study on the one hand, and from the arts,humanities and social sciences on the other. These parts of our "two cultures" are better received when they can be related one to another. This theme was voiced strongly four decades ago by Samuel Florman in his Engineering and the Liberal Arts, where he argued[3] that "unless the liberal arts can be approached through engineering, they will seem lifeless and frivolous to those of us who are professional engineers." Teachers of writing agree with Florman's insistence that students work relate to their disciplinary focus. For example, the editors Leithauser and Bell note that "Student writers often do better work when readings reflect their special interests", and thus justify their assembly of The World of Science: An Anthology for Writers[4] We similarly here explore our French experience in combining foreign language, lecture, and engineering laboratory as a bridge between engineering and a foreign culture.

The present CPE-Lyon combination of foreign language and laboratory instruction would appear to satisfy Ashby's need to provide "culture through a man's specialty,", to provide an example of Florman's "bridges" between engineering and the humanities, and to offer exercises consistent with the Liethhauser-Bell counsel that "student writers often do better when readings reflect their special interests."

Not all sources agree that foreign language instruction is an urgent component of 21st century engineering education. The NAE report The Engineering of 2020: Visions of Engineering in the New Century[5] urges that engineering educators pay attention to "working in teams", "public understanding of technology", "the global economy", and the "need to work in teams, communicate with multiple audiences, and immerse themselves in public policy debates ". Despite these endorsements of integrating engineers into larger fabrics of campus and culture, the report remains remarkably silent on the need for foreign language instruction. Given the typical integration of "language and cultures" in most college and university foreign language offerings today, this lack of language endorsement is all the more remarkable, and represents a lost advocacy opportunity. We note that, in contrast to the NAE (lack of) position, most European engineering schools require study of at least one foreign language.

The EC 2000 criterion (h) requires that engineering students understand "engineering solutions in a global and societal context"[6]. One approach to address this learning objective is to utilize integration of engineering lecture cameos or laboratory device demonstrations into US foreign language class instruction, examples of which were cited by Kennedy at al[7] and Ollis et al[8] including both stateside and overseas examples. The present paper describes a complementary position: the presentation of both language and lab instruction by French (i.e., non-US) faculty, in an overseas experience.

CPE Program in French language class and laboratory

The CPE 2007 program brochure, summarized in Table 1, highlights the parallel instruction in French language and laboratory, along with emphasis on the cultural opportunities of the host city Lyon. The original CPE program[1] was founded in 2000 with a goal of providing US engineering and chemistry students with a summer experience in France, which could then lead to an enhanced exchange of technical students in subsequent academic semesters. Several of our previous participants have returned for summer research experiences in Lyon, and one completed her final semester of a dual French/engineering degree, at CPE.

Table 1

INTERNATIONAL SUMMER SCHOOL IN FRANCE
Chemistry and Chemical Engineering, Lyon, France — 16June to 13 July, 2007

The Program

WHAT IS THE CPE INTERNATIONAL SUMMER SCHOOL ?
A five-week program organized by CPE Lyon engineering school that provides the opportunity for students to live and study in France, to develop language skills and experience a different cultural environment, to meet students from all over the world, while at the same time taking an undergraduate practical course in chemistry and/or chemical engineering.

WHO IS IT FOR ?
Undergraduate students in chemical engineering or chemistry, who have completed one or two years of university study.

WHAT DOES THE PROGRAM CONTAIN ?
• A course of French as a foreign language.
• An undergraduate practical course in Chemistry and/or Chemical Engineering. You will carry out at least 8 experiments in the teaching laboratories of CPE Lyon. At least 40 hours will be spent in the laboratory.

Examples of experiments to be carried out:

- Fluid flow: Determination of the general expression for pressure drop in a linear tube.
- Mixing: The determination of the relationship between the power number Np and the Reynolds number Re.
- Ebulliometry: Liquid-vapor equilibrium.
- Stephan's tube: Mass transfer by measurement of the evaporation of a liquid as a function of time.
- Chemical analysis of water : pH, conductivity, ion chromatography, alkalinity, hardness…
- Nitrogen analysis by the Kjeldahl method.
- Kinetics of a homogeneously catalyzed reaction followed by chromatography.
- Catalysis: Heck's reaction.

• Visits to industrial companies in the Rhône-Alpes region.
• Social and cultural visits and events including a day trip to the Beaujolais wine region.

Students will be looked after by the International Relations staff of CPE LYON throughout their stay.

Program calendar

Twenty three foreign students, including four chemical engineers from our US campus, and three others from Purdue, among a total of 20 US students, arrived on June 6, 2007, and were housed in student dorms located near ECAM, one of the four participating colleges in Lyon. The class calendar (Table 2) indicates parallel delivery of French instruction (12 classes totaling 36 contact hours) and chemistry/engineering laboratory involving 57 contact hours (9 experiments in 13 labs of various lengths (usually 3 or 4 hours) and a final day long project of 7 hours).

Table 2

Program calendar	Morning(3 hrs)	Afternoon(4 hrs)
Wed June 6	Arrive ECAM	19 HR: RECEPTION
Thur June 7	Summer School intro.	Tour Saint-Paul quarter IT resources at ECAM
Fri June 8	French class 1	Guided visit of Old Lyon
Mon June 11	Tour of CPE-Lyon	Lect 1: Lab Safety
Tue June 12	French class 2	Lect 2: Raising cultural awareness
Wed June 13	French class 3	Lab 1: UV spectroscopy
Thur June 14	French class 4	Industry visit 1: Lyon silk factory
Fri June 15	OPEN	OPEN
Mon June 18	Lect 3:Raising cultural awareness (continued)	
Tue June 19	French class 5	Visit ECAM labs
Wed June 20	French class 6	Lab 2: Kjeldah analysis
Thur June 21	French class 7	Industry visit 2:Renault trucks
Friday June 22	Industry visit 3: Beaujolais viticulture & wine making (all day)	
Mon June 25	OPEN	French class 8
Tue June 26	French class 9	Higher Education in France Dinner: Lyon
Wed June 27	French class 10	Lab 3: Pressure drop in fluid flow
Thur June 28	French class 11	Dinner: Restaurant “La Cuvee”
Fri June 29	Lab 4: Mixing	OPEN
Mon July 2	OPEN	French class 12
Tue July 3	Lab 5: Water analysis	Presentations by French students Lab 5: (continued)
Wed July 4	French final exam	Lab 6: Thermo cycle
Thur July 5	Lab 7: Fick’s law (diffusion)	OPEN
Fri July 6	OPEN	OPEN
Mon July 9	OPEN	Lab 7: (continued)
Tue July 10	Lab 8: SN1 rxn.	Lab 8: (continued)
Wed July 11	Lab 9: Heck’s rxn.	Lab 9 (continued)
Thur July 12	Lab project	Lab project
Fri July 13	Review & Evaluation	

The French lab hours exceeded those of our conventional 4 unit 14 week US semester, and the language class plus the obvious lab translation time corresponded with the effort needed for a 3 unit US language course. All lab and language materials received and/or created by the students were subsequently reviewed by other US engineering and foreign language faculty. We note that the US ubiquity of both French lecture/recitation classes and chemical engineering laboratories indicates that credit transfers from such overseas experiences should be easy to arrange at most US engineering campuses. Thus, the CPE program is a model for an early international experience in chemical engineering and chemistry. Other non-English speaking engineering schools could clearly offer corresponding experiences in their chosen concentration(s).

The six week syllabus in Table 2 suggests parallel, but not integrated, efforts in French language instruction and chemistry/chemical engineering laboratory practice. While the French language instruction occurred at two levels (for students with low or moderate prior French experience), the lab was integrative in the sense that instructions were provided in French, and the US students translated these into English, then wrote their lab reports in standard form for our US engineering campus program. Our US students downloaded our typical lab manual from our US campus website prior to departure for France, and followed its designated report format. These practices allowed easy post-visit course credits awarded by our US lab and foreign language instructors, respectively, for the student work returned to our US campus.

CPE-Lyon graded both French and laboratory efforts of all participating students, and provided official transcripts for the summer experience. Consistent with our US campus policy, these credits counted towards our graduation requirement of 126 units, but are not included in our US campus grade point calculation. The French grading was consistent with the American style, and all four students received predominantly As, with a few Bs, for their language and laboratory efforts.

Cultural environment

A foreign travel opportunity always provides new contexts within which to view life, and the CPE program of Table 2 is no exception. Beyond the evident academic strengths, the visit is rich in cultural and informal education possibilities. The five included weekends allowed local city watching as well as informal trips to Paris(capital), Grenoble (French alps), and Marseille (polycultural Mediterannean city). The nine scheduled OPEN periods allowed for downtown visiting opportunities at times when French museums and stores, usually closing at 6 pm nightly, were still open. The three formal tours of St. Paul quarter, near student dorms, Vieux (Old) Lyon, and the school CPE-Lyon provided students with a broad introduction to their residential and instructional surroundings, respectively.

While no formal diary or report of informal experiences was required, we note student exposure to the following items:

TGV (train a tres grande vitesse (high speed strain) represented the French leadership in train transportation technology, used by students for their Paris and Marseille trips.

Lyon "has an intense artistic and cultural life, with the Opera House, the Auditorium, around 15 theatres, many museums, and Roman remains" (including an amphitheater, used for music and drama performance).

Lyon is France's "capital gastronimique".

Lyon's technical achievement are reflected in the local museums including silk and automation of weaving, automobiles and Michelin, and cinema, representing the motion picture invention by the Lumiere brothers.

Cost of program credits

While finances do not figure into the academic content of the program, they do strongly impact the potential participation by US students. Details aside, given the free tuition for the language (but not lab) course provided by CPE, the net additional cost to US students in public universities is simply the air fare for their six week of French experience. US students from private schools, or those attending a state campus as out-of-state students, would find the additional net cost to be zero or negative vs the price at their home US institutions for a 5-6 week summer semester worth 6-7 credits.

Evaluation of orientations, language classes , and industrial tours.

The French programs at Lyon involve the collaborative offerings from several academic institutions, including CPE (chemistry/chemical engineering). Thus we present in Table 3 the evaluation thoughts from the 20 students in the overall programs (four French institutions, including CPE) as well as the 7 students (among 20) who partook of the CPE laboratory component.

Table 3
Evaluation of Overall Program (20 respondents among 23 students)

1.	French language instructors (3) (4.0 max possible):	3.67, 3.63, 3.67
2.	Seminar on French/European education	3.26/4.0
3.	Intercultural presentation	3.16/4.0
4.	Industry visits/tours	
	Old Lyon	3.67/4.0
	Lyon silk factory	3.09/4.0
	Beaujolais wine region	3.80/4.0
	Renault trucks	2.56/4.0
5.	Reception/welcome by …	
	French students	3.05/4.0
	French staff(faculty, international relations)	3.85/4.0
6.	Lodging	2.95/4.0

These data show firstly that the French language instructors were all excellent, consistent with our prior non-credit experience (2000-2006) [1]. The two presentations on "French education" and "Intercultural Differences" forced students to compare their known American circumstances with education approaches and cultural styles relatively unfamiliar to them, a fine time for reflecting life as lived by others. Industry tours ranged from Beaujolais winemaking (well received) to the Renault truck assembly (modest on this first pass). We note that the highly ranked visits to Old Lyon (Vieux Lyon) and the Beaujolais region had more opportunity for food and beverage consumption than did the lower rated truck assembly and silk making sites.
The hosting and welcoming activities of the professional staff were very well regarded vs the reception by the less practiced French students.

The "General Impressions" of all 20 students (of 23 attending) completing the related summer programs are shown in Table 4. The program was well balanced, with six different categories rated first choice "What did you like best?" for a tally of 25 among the 20 responding students (several students listed more than one choice). In pleasant contrast, "What did you like least ?" received only 5 responses, with no single item apparent as weakest. Several "least liked" items related specifically to lodging, and may thus account fort the relatively lower rating of student lodging, its outstanding location near Vieux Lyon not withstanding.

Table 4
General Impressions

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1. What did you most like about the program ?
   Meeting all 23 students(9); visits/tours(7), French classes (4), trip/voyage(3), exposure to French language and culture(2), visiting Lyon(2), lab course(2)
2. What did you like least about the program ?
   Limited computer access on weekends (1); not enough meals organized in dorm(1); not enough technical seminars or visits (1); start too early(1); student restaurant too far from dorm(1).
3. Did you integrate well with other Summer School students ?
   Yes(14); no (2); yes, met many students first evening in café, and became friends over visit(1); very easily (1); yes, also at ease with French students(1); "totally" (1).
4. What do you recommend for future Summer Schools ?
   Lengthen stay(3); open computer room on weekends (2); learn more vocabulary to provide greater weekend freedom in town(2); post (cultural) activities occurring in Lyon(1); teach labs in English(1); lengthen tour of Lyon (1).
5. Would you recommend the program to students at your university ?
   Yes(20).

Laboratory structure

Seven US students elected the language and laboratory program of Table 2. While the language portion was common to that for all four participating Lyon institutions, the laboratory shown in Table 2 was for only those students electing the CPE-Lyon track of participation. The seven experiments listed include items common to many chemical engineering (items 3,4,5,6, 7, and 9) and/or chemistry (items 1, 2,5, and 9) laboratories in the US. This strong curricular overlap with US syllabi aided easy reception by the students' home campus, and thus eventual post-visit receipt of lab credit.

All seven US engineering students electing the CPE (language + laboratory) program of Table 2also completed an evaluation of the laboratory experiments; results are summarized in Table 5.

Table 5
Evaluation of chemical engineering/chemistry laboratory (7 responses among 7 students)

		Excellent	Good	Average	Poor
1.	Ultraviolet spectroscopy	1	3	3	
2.	Kjeldahl analysis	2	5		
3.	Pressure drop in fluid flow	4	2	1	
4.	Mixing and agitation	5	1	1	
5.	Water analysis	3	2	1	1
6.	Ebulliometry (vapor-liquid equil.)	4	1	2	
7.	Stephan's tube(diffusion)	4	2	1	
8.	Projects on 3 & 4 above	3	3	1	
9.	Catalysis and kinetics	5	2		

These evaluations indicate that this first French experience in providing an engineering lab, in French, was well received by the US students. The average score across all experiments was 3.3/4.0. CPE has indicated that if all participating US students next year are again chemical engineers, it will drop some of the chemistry experiments, and add others with more of an engineering flavor.

While the French classes and lab experiments of Table 2 appear to be independent, the major connection was use of instruction in French for the laboratory procedures. As indicated previously, these were translated into English by the laboratory teams (1 team of four for our US campus). The instructions contained both descriptive and analytical text. Samples of each type of instruction are provided below in Table 6(descriptive) and Table 7 (analytical), along with the student translations. This unusual experience for all nine lab experiments provided an example professional task executed within a foreign language

Table 6: Descriptive text laboratory sample: Nitrogen analysis

ORIGINAL: Dosage de L'azote organique par la methode de Kjeldahl

La methode de Kjeldahl a pour but de determiner le pourcentage d'azote dans les substances organiques ou inorganiques. Elle est applicable pour le dosage de l'azote dans les amines, les amides, les sels d'ammonium, etc. Elle ne permet cependant pas le dosage direct dans les nitrites, nitrates, nitrosyles, cyanures, qu'il faut d'aabourd reduire en ammoniac.

C'est une methode normallzee et tres utilisee dans le domaine de l'environnement, afin de determiner la pollution liee a l'azote: engrais, effluents d'elevage, effluents agro-alimentaires, boues, etc…Cette technique est egalement appliquee dans l'agro-alimentaire pour doser in particulier le taux de proteins dans des echantillons comme le lait.

En effet, les proteins sont consitutees d'enchainement d'acide amines plus ou moins complexes. Ells sont caracterisees par un taux moyen d'azote de 16%.
Le dosage de l'azote permet donc un dosage des proteins dans un echantillon alimentaire par exemple. Le pourcentage de proteins est: %N * 6.25 (6.25 represente le coefficient de Kjeldahl). Le temps de mineralization d'un echantillon contenant des proteins etant relativement long, nous determinerons le taux d'azote sur des echantillons d'acides amines.

TRANSLATION: Determination of organic nitrogen by Kjeldahl method

The purpose of the Kjeldahl method is to determine the percentage of nitrogen in organic or inorganic substances. It is applicable for the proportioning of nitrogen in amines, amides, salts of ammonium, etc. It however does not allow direct proportioning in the nitrites, nitrates, nitrosyles, cyanides, for which it is initially necessary to reduce to ammonia.

It is a standardized method and often used in the environmental field, to determine pollution related to nitrogen: manure, effluents of breeding, agro-alimentary effluents, muds, etc. This technique is also applied to agro-alimentary materials, to proportion in particular the percentage of protein in samples like milk.

Proteins consist of sequences of complex amino acids. They are characterized by an average percentage of 16% nitrogen. The proportioning of nitrogen allows a proportioning of proteins in a food sample for example. The percentage of proteins is : %N * 6.25 (6.25 represents the coefficient of Kjeldahl).The time for mineralization of a sample containing proteins is relatively long, thus we will (instead) determine the percent of nitrogen in samples of amino acids.

Table 7: Quantitative text : laboratory sample for fluid flow

ORIGINAL: Perte de charge dans une conduite rectiligne
Objectif: Etablir l'expression generale des pertes de charge dans les conduits.
Rappels de theorie. Application de l'analyse dimensionnelle a l'etude de l'ecoulement d'un fluide newtonien:

L'analyse dimensionnelle permet d'etablir la forme de l'expression donnant la perte de charge qui apparait lorsqu'il y a ecoulement dans un canalization lisse.

Nous supposons l'ecoulement permanent et isotherme, et le fluide incompressible. Pour ces raisons, tous les troncons de conduite sont equivalents: dans chaque metre de canalization on doit disperser la meme quantite d'energie. La chute de pression est donc proportionnelle a la longueur de la conduite, et nous cherchons immediatement l'expression de $(\Delta P)/L$, perte de charge par metre de conduite.

Les seules variables dont depend $(\Delta P/L)$ sont alors:

D diametre de la conduite
V vitesse moyenne du fluide
Ø et μ mass volumique et viscosite dynamique du fluide

Montrer qu'il vient:

$$(\Delta P/L)\,(2D/\o v2) = f\,(D\o v/\mu)$$

Le premier invariant de similitude est appele coefficient de perte de charge ou nombre de Darcy, ingenieur français qui dota Dijon d'eau potable en 1839. Il est note Da our f.

$$Da = f/4 = (\Delta P/L)\,(2D/\o v2)$$

Le second invariant de similitude est le nombre de Reynolds Re:

$$Re = D v \o / \mu$$

TRANSLATION: Pressure loss in a rectilinear conduit
Objective: Establish the general expression for pressure drop in a conduit
Recall theory. Application of dimensional analysis to flow of a Newtonian fluid:
Dimensional analysis makes it possible to establish the form of the expression giving the pressure drop which appears when there is flow in smooth piping.

We assume permanent and isothermal flow, and an incompressible fluid. For these reasons, all sections of the conduit are equivalent; in each meter of piping one must disperse the same quantity of energy. The pressure drop is this proportional to the length of the conduit, and we immediately seek the expression for $\Delta P/L$, pressure loss per meter of conduit.

The only variable on which $\Delta P/L$ depends are then:

D diameter of conduit
v mean velocity of the fluid
ø and μ density and kinematic viscosity of the fluid

The equation becomes: $(\Delta P/L)\,(2D/\o v2) = f\,(D\o v/\mu)$

The first invariant of similarity is called the pressure drop coefficient or Darcy number, after a French engineer who equipped Dijon with drinking water in 1839. It denoted Da,

$$Da = (2D/\o v2)$$

The second invariant of similarity is the Reynolds number

$$Re = D\o v/\mu \ \ldots$$

Reflections

The integration of foreign language instruction and disciplinary technical instruction within individual courses is rare. Outside of our own efforts in Spanish [7,8] and French[8] , two recent papers are encouraging. Language instructor Caldwell[9] discusses her experience integrating service learning activities into a Spanish language course, a logical association because the student service occurred within a pre-dominantly Hispanic community. Neville and Brigg[10] proposed but have not executed use of problem-based learning (PBL) modules to place Spanish into a biological engineering curriculum. Our integration efforts here have taken a broader approach, introducing foreign language immersion into a laboratory program for engineering students.

An additional, if less tangible aspect, is also present. One of the ABET/EC 2000 engineering criteria for the undergraduate degree is "the broad education necessary to understand the impact of engineering solutions in a global/societal context". The present (French + engineering) education experience at CPE-Lyon allows not only the obvious use of second language in a professional setting (chemical engineering laboratory) but also first hand visits to "engineering solutions" in their original contexts, including architectural structures (amphitheater, cathedral, church, palace), medieval timekeeping (astronomical clock), 19th century industrial revolution and the automation of textile production (silk factory and weaving), and timeless biotechnology (Beaujolais winemaking).

We believe that such formal and informal integrations of "language, technology, and culture" represent a path forward for training US engineers for the globalized 21st century. This view is supported by the generally positive evaluations by twenty summer 2007 US student participants

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